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Sowadski et al.

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(54) **PERFORMANCE-BASED SIMULATION SYSTEM FOR AN AIRCRAFT**

(71) Applicant: **The Boeing Company**, Chicago, IL (US)

(72) Inventors: **Clifford Bradley Sowadski**, Eureka, MO (US); **Brandt Wilson Dargue**, Kirkwood, MO (US); **Robert James Lechner**, St. Charles, MO (US)

(73) Assignee: **THE BOEING COMPANY**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/083,078**

(22) Filed: **Nov. 18, 2013**

(65) **Prior Publication Data**

US 2014/0080099 A1 Mar. 20, 2014

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/304,514, filed on Nov. 25, 2011, now Pat. No. 8,616,884, which is a continuation-in-part of application No. 12/628,831, filed on Dec. 1, 2009.

(51) **Int. Cl.**

G09B 19/16	(2006.01)
G09B 9/02	(2006.01)
G09B 9/44	(2006.01)
G09B 9/54	(2006.01)

(52) **U.S. Cl.**
CPC .. ***G09B 9/02*** (2013.01); ***G09B 9/44*** (2013.01); ***G09B 9/54*** (2013.01)

(58) **Field of Classification Search**
CPC G09B 9/00; G09B 9/02; G09B 9/08
USPC 434/29–72
See application file for complete search history.

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Mendro et al., "Integrated Live and Simulation Environment System for an Aircraft," U.S. Appl. No. 12/628,831, filed Dec. 1, 2009, 62 pages.

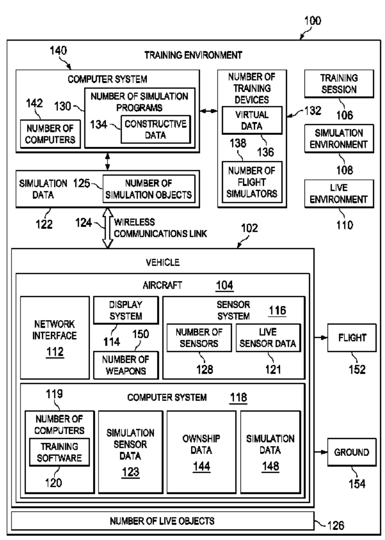
(Continued)

Primary Examiner — Timothy A Musselman
(74) *Attorney, Agent, or Firm* — Yee & Associates, P.C.

(57) **ABSTRACT**

A method and apparatus for training in an aircraft. An apparatus comprises an aircraft, a display system associated with the aircraft, a sensor system associated with the aircraft, and a training processor configured to be connected to the aircraft. The training processor is further configured to receive information about an operator, generate constructive data for simulated objects, generate simulation sensor data using the constructive data, and present the simulation sensor data with live sensor data generated by the sensor system on the display system. The training processor is further configured to identify a performance of the operator based on a policy and modify a simulation based on the performance of the operator.

20 Claims, 20 Drawing Sheets



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Sowadski et al., "Augmented Reality System for Field Training," U.S. Appl. No. 13/016,014, filed Jan. 28, 2011, 67 pages.
Lechner et al., "Integrated Live and Simulation Environment System for an Aircraft," U.S. Appl. No. 13/304,514, filed Nov. 25, 2011, 78 pages.
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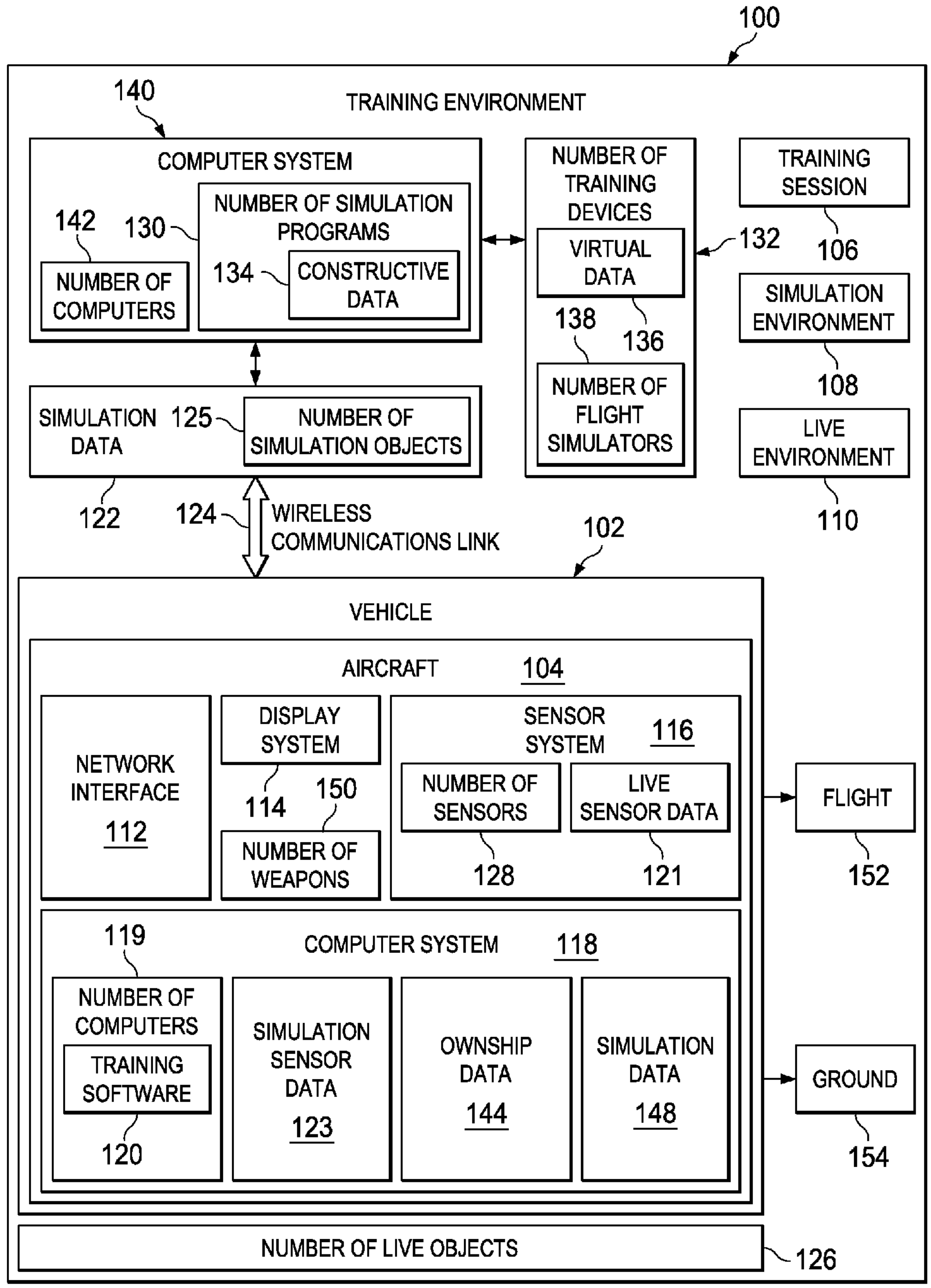
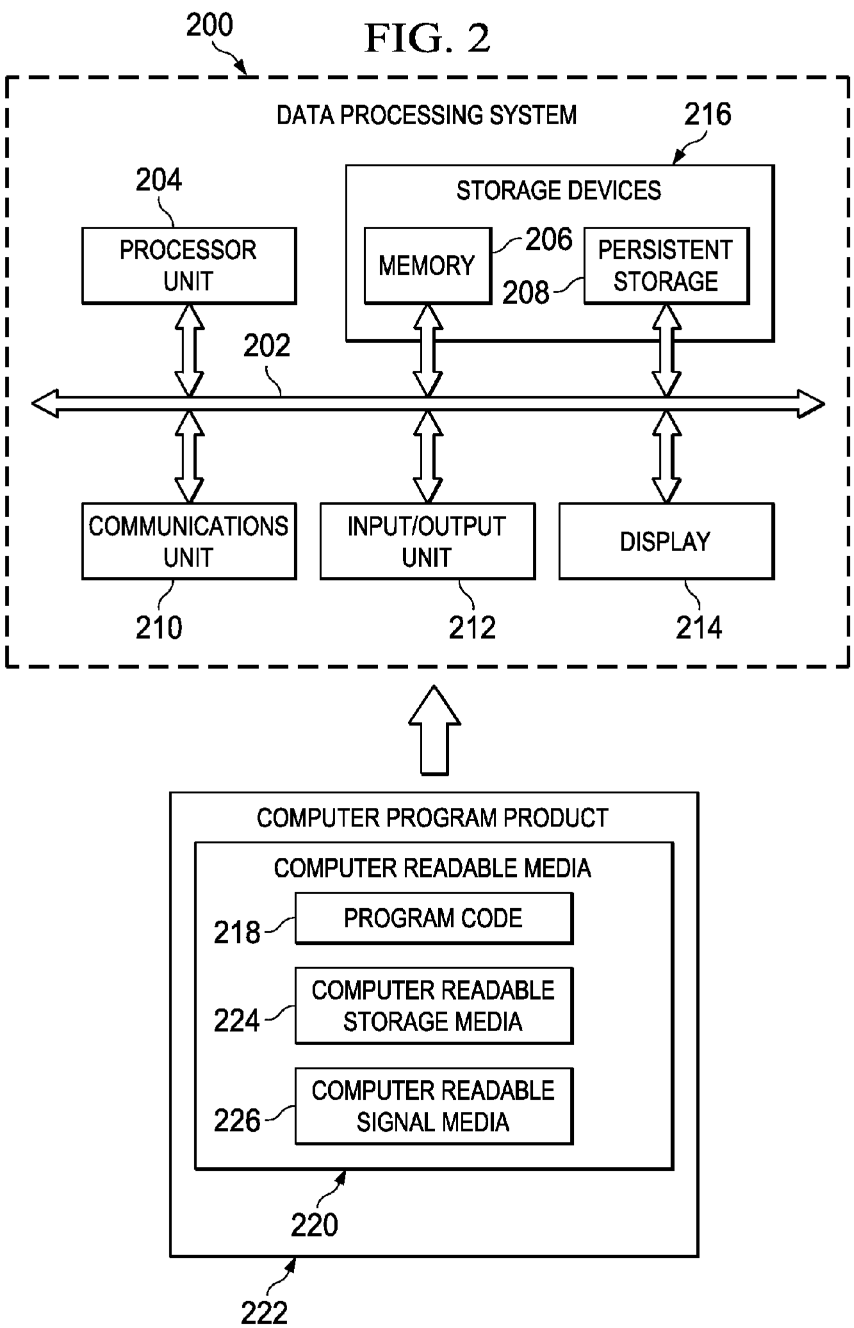

100
TRAINING ENVIRONMENT
140
COMPUTER SYSTEM
142
NUMBER OF COMPUTERS
130
NUMBER OF SIMULATION PROGRAMS
134
CONSTRUCTIVE DATA
NUMBER OF TRAINING DEVICES
VIRTUAL DATA
132
138
136
NUMBER OF FLIGHT SIMULATORS
TRAINING SESSION
106
SIMULATION ENVIRONMENT
108
LIVE ENVIRONMENT
110
SIMULATION DATA
125
NUMBER OF SIMULATION OBJECTS
122
124
WIRELESS COMMUNICATIONS LINK
102
VEHICLE
AIRCRAFT 104
NETWORK INTERFACE 112
DISPLAY SYSTEM
114
150
NUMBER OF WEAPONS
SENSOR SYSTEM 116
NUMBER OF SENSORS
LIVE SENSOR DATA
128
121
FLIGHT
152
119
COMPUTER SYSTEM 118
NUMBER OF COMPUTERS
TRAINING SOFTWARE
120
SIMULATION SENSOR DATA 123
OWNSHIP DATA 144
SIMULATION DATA 148
GROUND
154
NUMBER OF LIVE OBJECTS
126

FIG. 1

FIG. 2


200
DATA PROCESSING SYSTEM
216
STORAGE DEVICES
204
PROCESSOR UNIT
MEMORY
206
208
PERSISTENT STORAGE
202
COMMUNICATIONS UNIT
INPUT/OUTPUT UNIT
DISPLAY
210
212
214
COMPUTER PROGRAM PRODUCT
COMPUTER READABLE MEDIA
218
PROGRAM CODE
224
COMPUTER READABLE STORAGE MEDIA
226
COMPUTER READABLE SIGNAL MEDIA
220
222

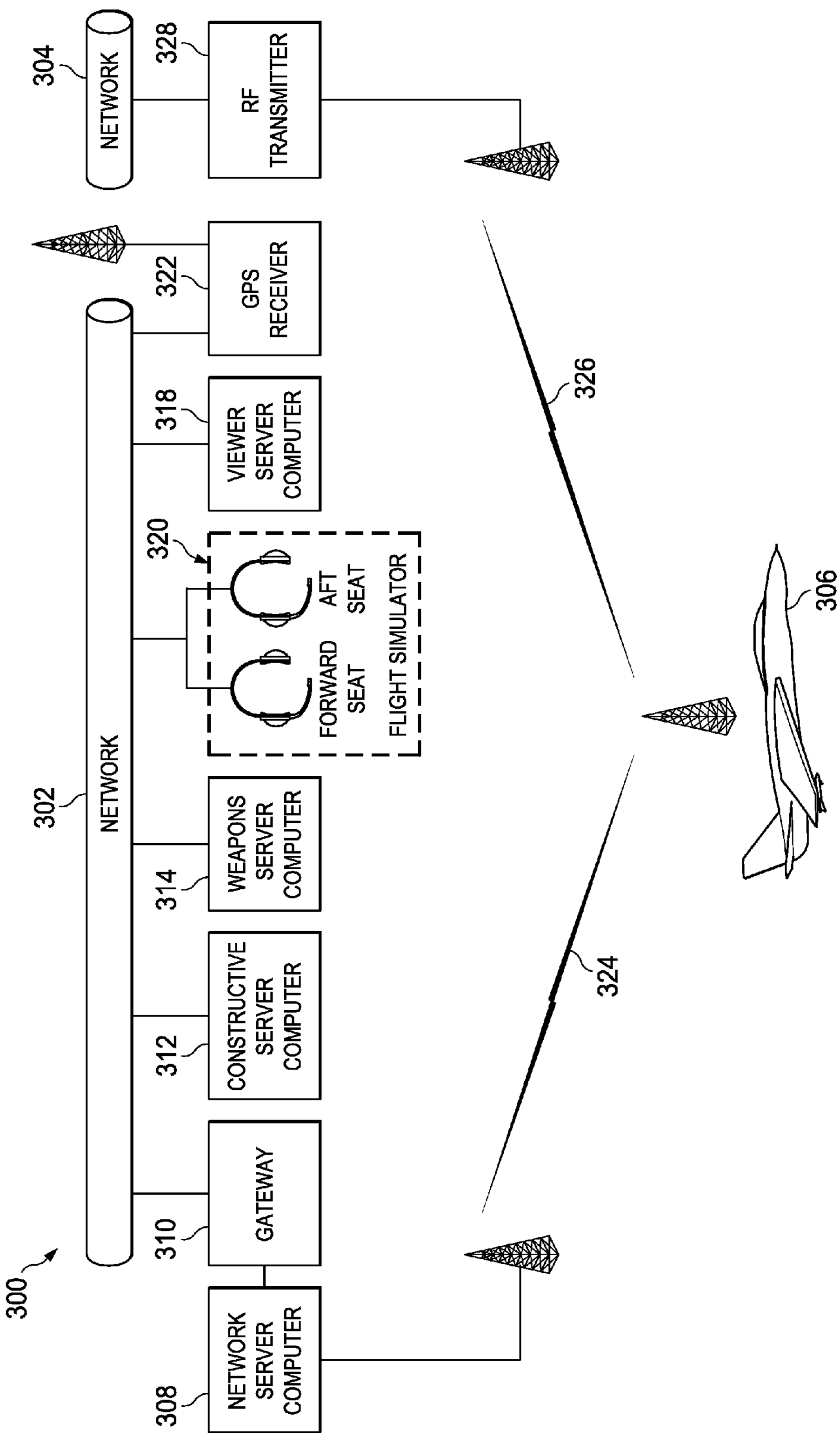
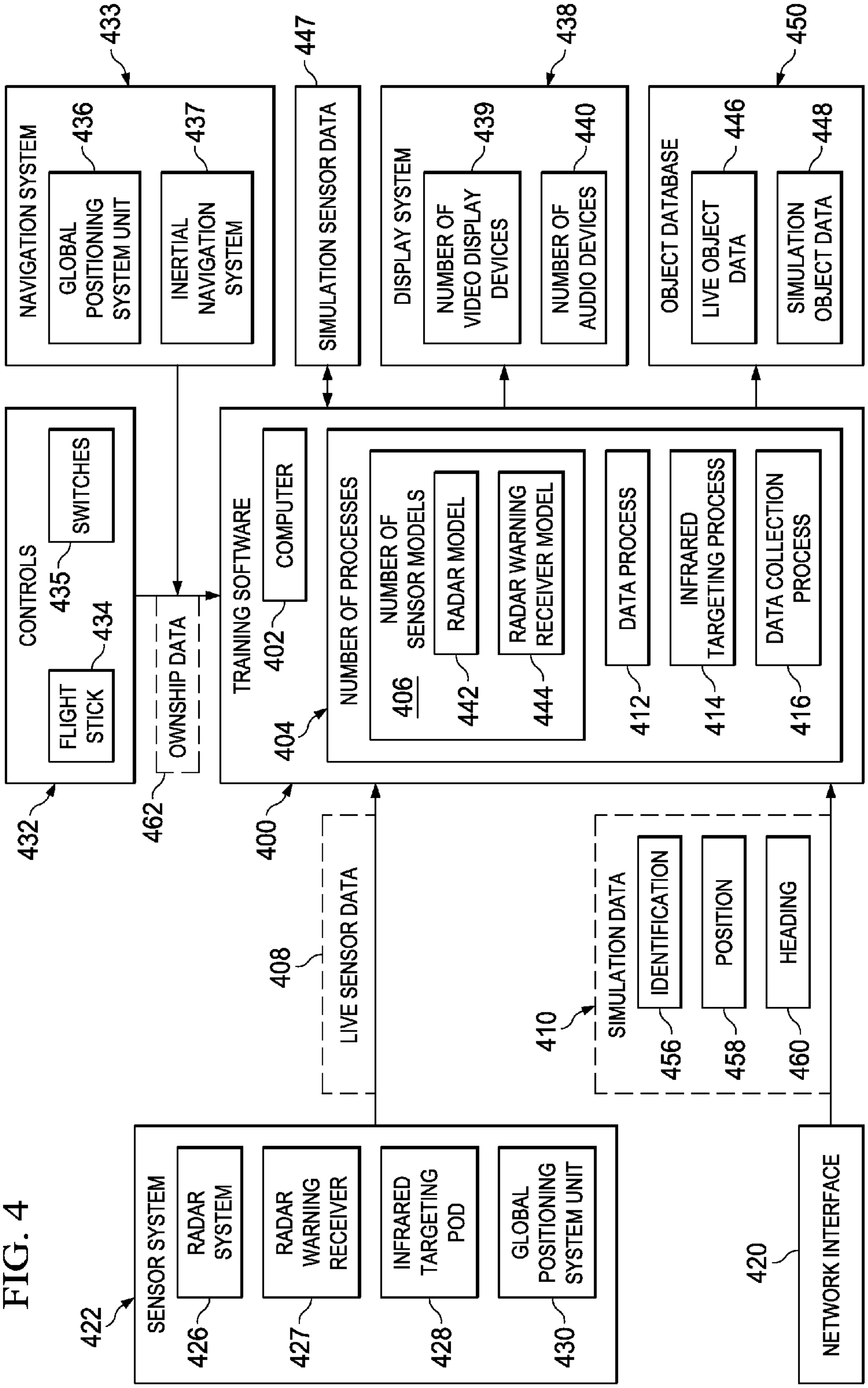

300
304
NETWORK
328
RF TRANSMITTER
322
GPS RECEIVER
302
NETWORK
318
VIEWER SERVER COMPUTER
320
FORWARD SEAT
AFT SEAT
FLIGHT SIMULATOR
314
WEAPONS SERVER COMPUTER
312
CONSTRUCTIVE SERVER COMPUTER
310
GATEWAY
308
NETWORK SERVER COMPUTER
326
324
306

FIG. 3



NAVIGATION SYSTEM
433
GLOBAL POSITIONING SYSTEM UNIT
436
INERTIAL NAVIGATION SYSTEM
437
SIMULATION SENSOR DATA
447
DISPLAY SYSTEM
438
NUMBER OF VIDEO DISPLAY DEVICES
439
NUMBER OF AUDIO DEVICES
440
OBJECT DATABASE
450
LIVE OBJECT DATA
446
SIMULATION OBJECT DATA
448
CONTROLS
432
FLIGHT STICK
434
SWITCHES
435
OWNSHIP DATA
462
TRAINING SOFTWARE
400
COMPUTER
402
NUMBER OF PROCESSES
404
NUMBER OF SENSOR MODELS
406
RADAR MODEL
442
RADAR WARNING RECEIVER MODEL
444
DATA PROCESS
412
INFRARED TARGETING PROCESS
414
DATA COLLECTION PROCESS
416
LIVE SENSOR DATA
408
SIMULATION DATA
410
IDENTIFICATION
456
POSITION
458
HEADING
460
SENSOR SYSTEM
422
RADAR SYSTEM
426
RADAR WARNING RECEIVER
427
INFRARED TARGETING POD
428
GLOBAL POSITIONING SYSTEM UNIT
430
NETWORK INTERFACE
420

FIG. 4

FIG. 5

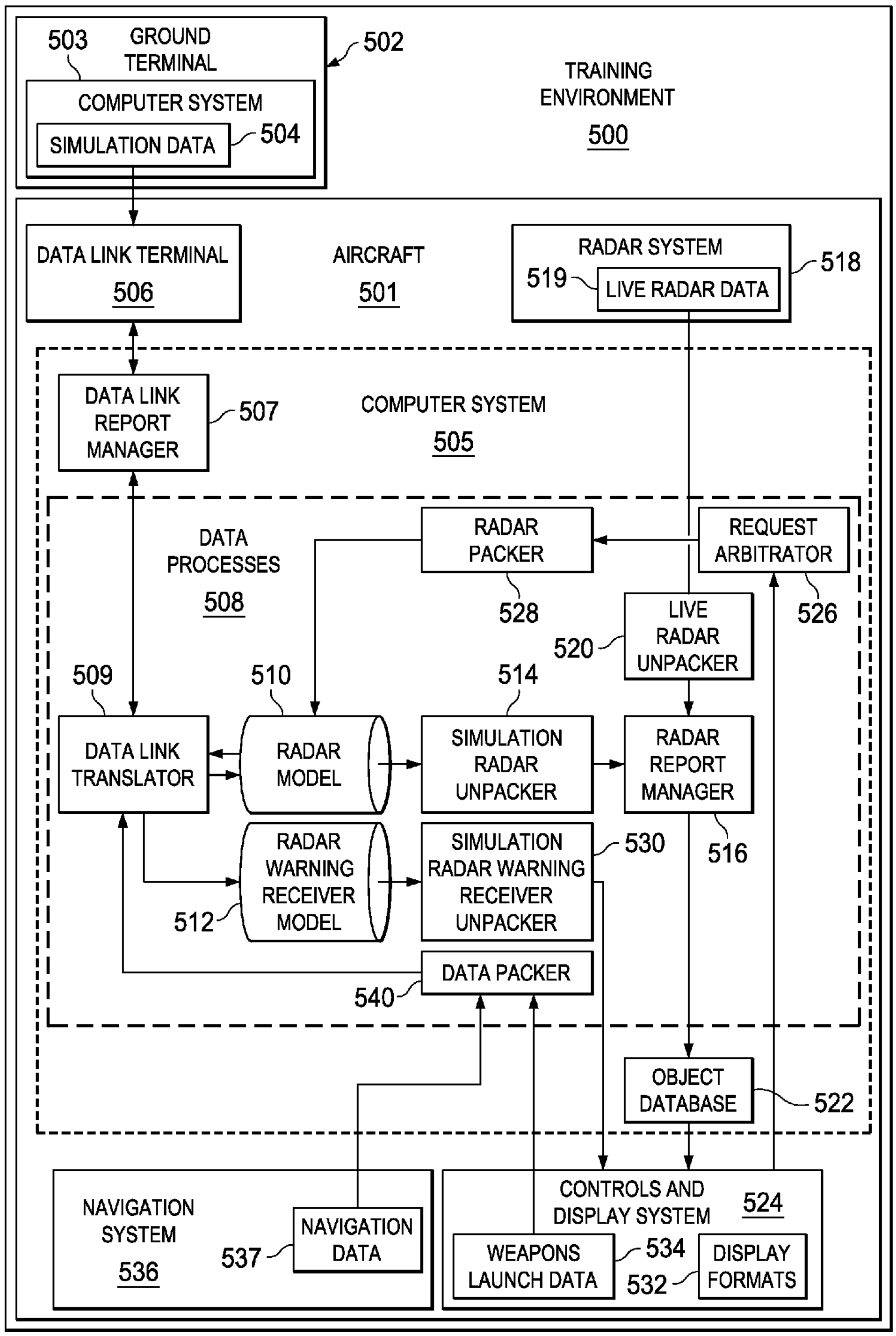
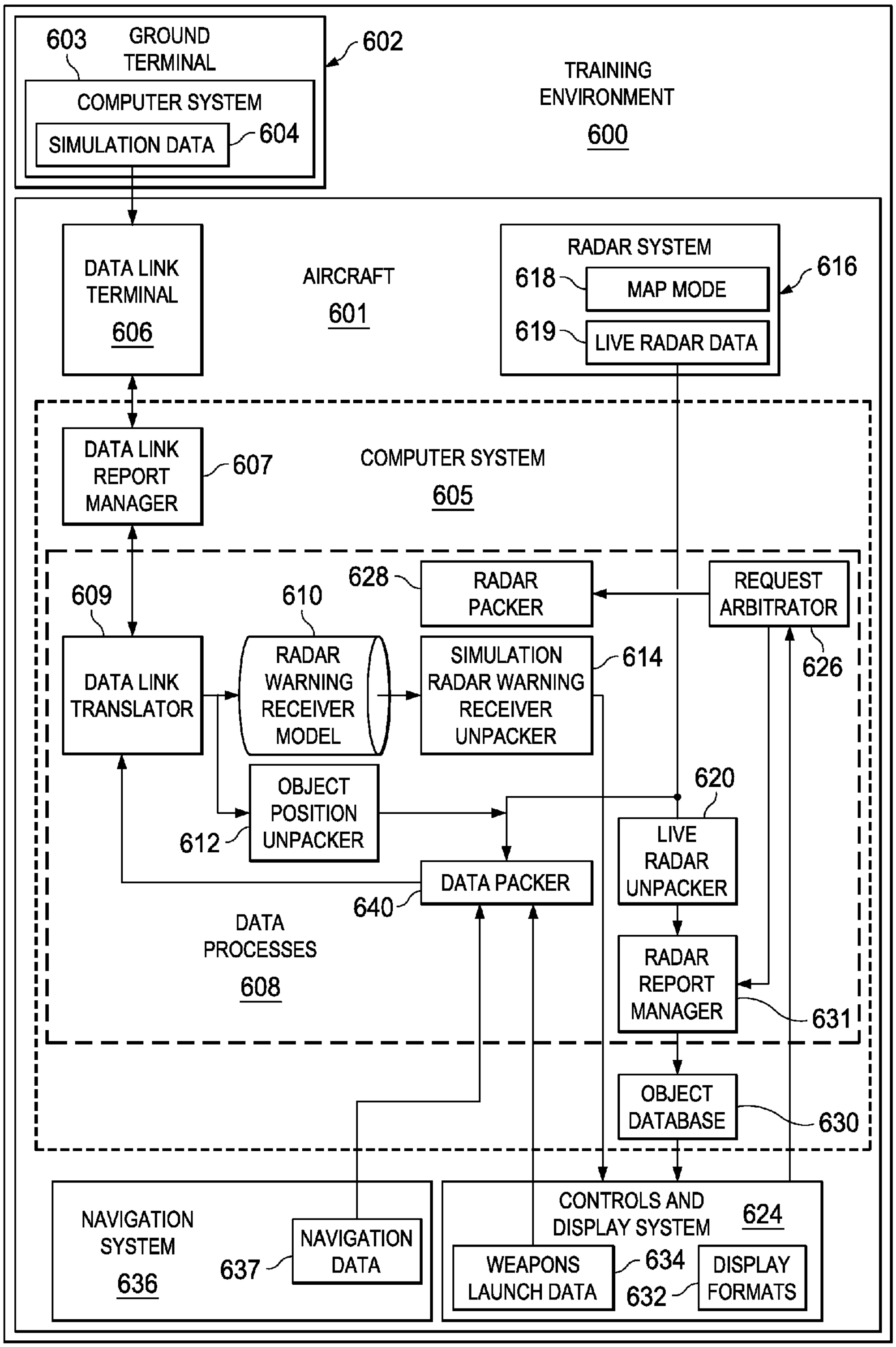
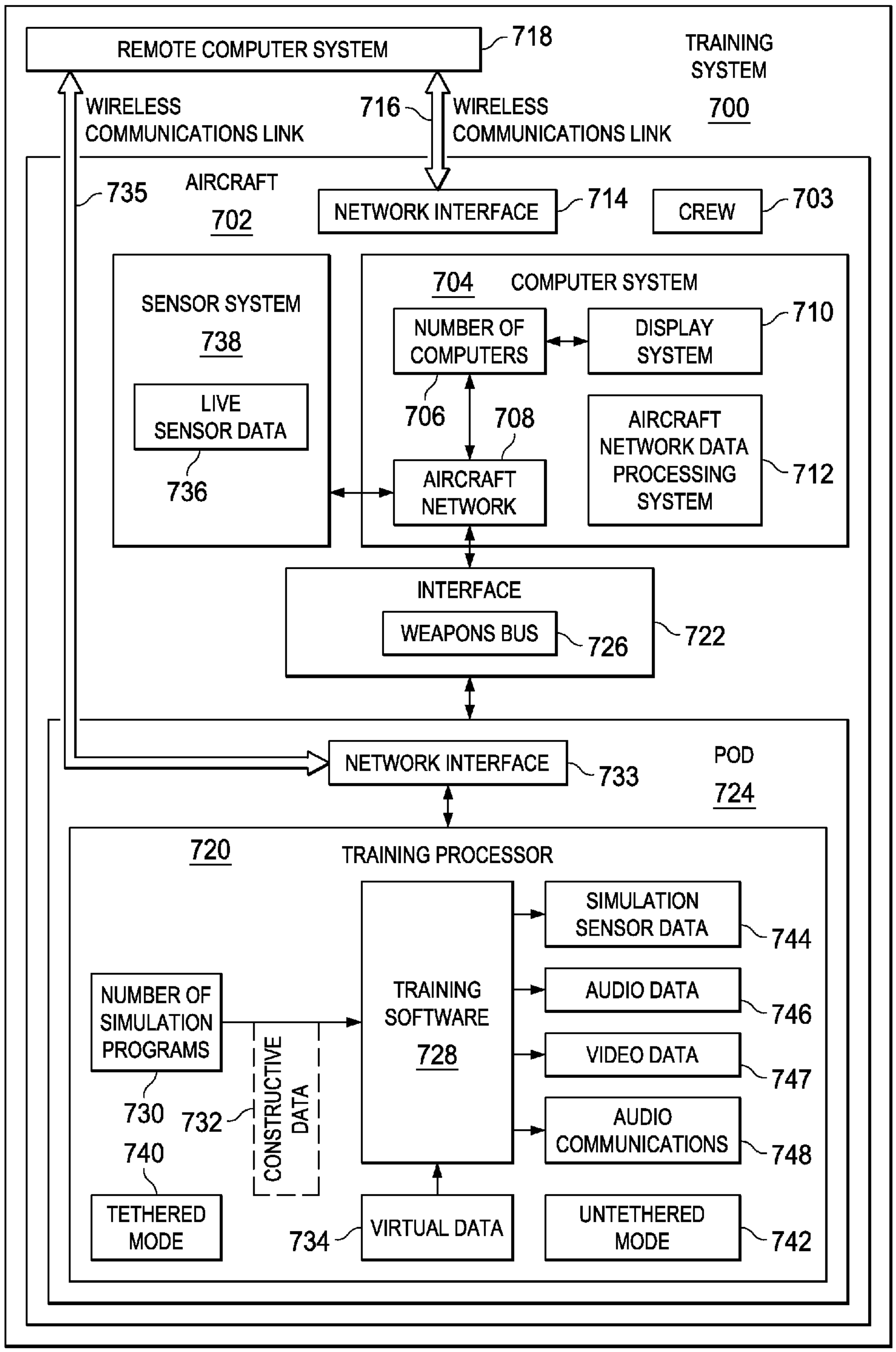

TRAINING ENVIRONMENT
500
GROUND TERMINAL
502
503
COMPUTER SYSTEM
SIMULATION DATA
504
AIRCRAFT
501
DATA LINK TERMINAL
506
RADAR SYSTEM
518
519
LIVE RADAR DATA
COMPUTER SYSTEM
505
DATA LINK REPORT MANAGER
507
DATA PROCESSES
508
RADAR PACKER
528
REQUEST ARBITRATOR
526
LIVE RADAR UNPACKER
520
509
510
514
DATA LINK TRANSLATOR
RADAR MODEL
SIMULATION RADAR UNPACKER
RADAR REPORT MANAGER
516
RADAR WARNING RECEIVER MODEL
512
SIMULATION RADAR WARNING RECEIVER UNPACKER
530
DATA PACKER
540
OBJECT DATABASE
522
NAVIGATION SYSTEM
536
NAVIGATION DATA
537
CONTROLS AND DISPLAY SYSTEM
524
WEAPONS LAUNCH DATA
534
DISPLAY FORMATS
532

FIG. 6



TRAINING ENVIRONMENT
600
603
GROUND TERMINAL
602
COMPUTER SYSTEM
SIMULATION DATA
604
DATA LINK TERMINAL
606
AIRCRAFT
601
RADAR SYSTEM
616
618
MAP MODE
619
LIVE RADAR DATA
DATA LINK REPORT MANAGER
607
COMPUTER SYSTEM
605
628
RADAR PACKER
REQUEST ARBITRATOR
626
609
610
DATA LINK TRANSLATOR
RADAR WARNING RECEIVER MODEL
SIMULATION RADAR WARNING RECEIVER UNPACKER
614
OBJECT POSITION UNPACKER
612
620
LIVE RADAR UNPACKER
DATA PACKER
640
DATA PROCESSES
608
RADAR REPORT MANAGER
631
OBJECT DATABASE
630
NAVIGATION SYSTEM
636
637
NAVIGATION DATA
CONTROLS AND DISPLAY SYSTEM
624
WEAPONS LAUNCH DATA
634
632
DISPLAY FORMATS

FIG. 7



REMOTE COMPUTER SYSTEM
718
TRAINING SYSTEM
700
WIRELESS COMMUNICATIONS LINK
716
WIRELESS COMMUNICATIONS LINK
735
AIRCRAFT
702
NETWORK INTERFACE
714
CREW
703
SENSOR SYSTEM
738
LIVE SENSOR DATA
736
704
COMPUTER SYSTEM
NUMBER OF COMPUTERS
DISPLAY SYSTEM
710
706
708
AIRCRAFT NETWORK
AIRCRAFT NETWORK DATA PROCESSING SYSTEM
712
INTERFACE
WEAPONS BUS
726
722
NETWORK INTERFACE
733
POD
724
720
TRAINING PROCESSOR
SIMULATION SENSOR DATA
744
TRAINING SOFTWARE
728
AUDIO DATA
746
NUMBER OF SIMULATION PROGRAMS
VIDEO DATA
747
CONSTRUCTIVE DATA
730
732
AUDIO COMMUNICATIONS
748
740
TETHERED MODE
734
VIRTUAL DATA
UNTETHERED MODE
742

FIG. 8

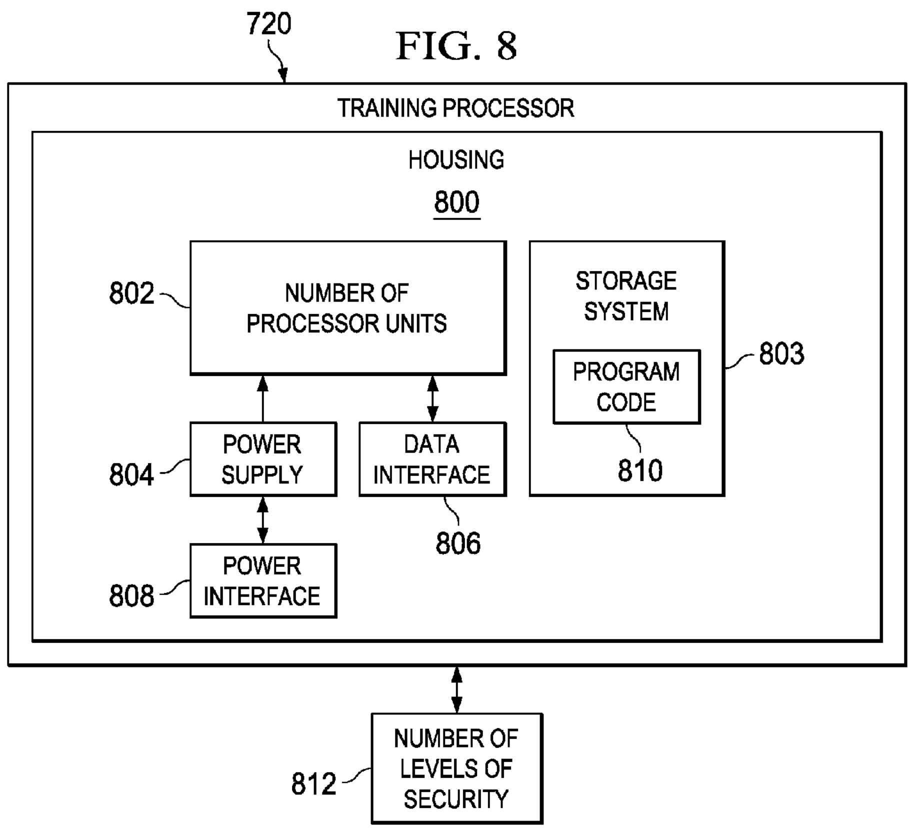
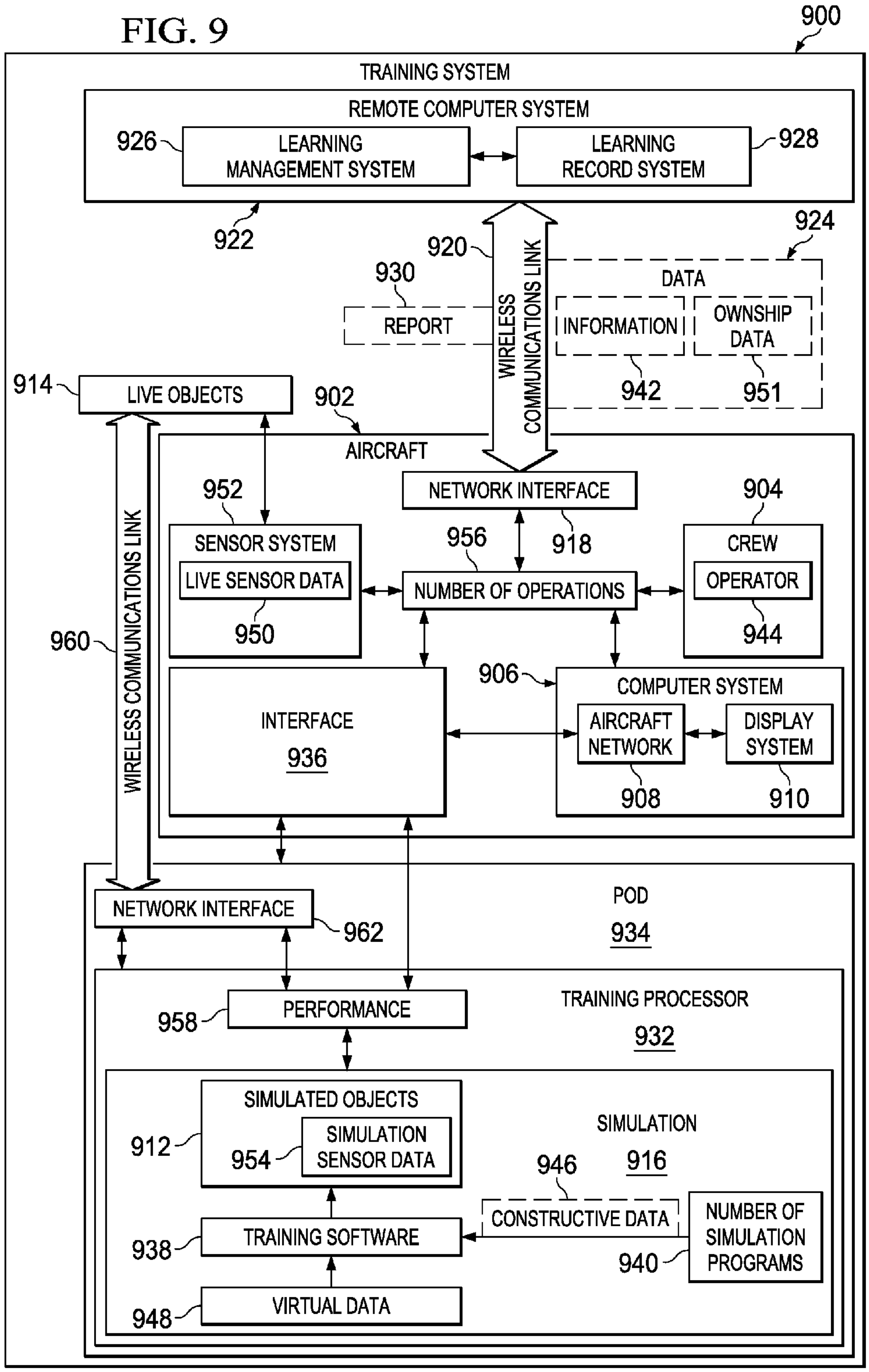
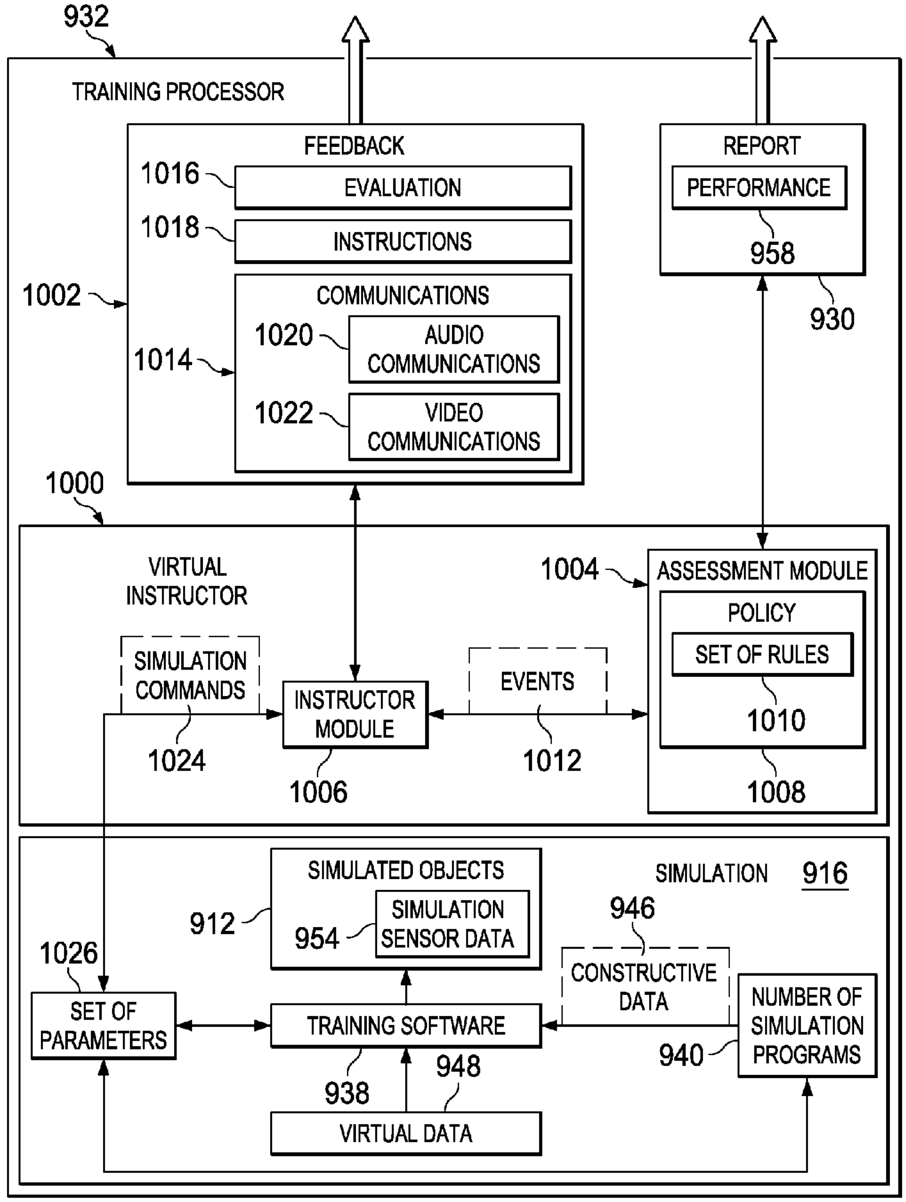

720
TRAINING PROCESSOR
HOUSING
800
NUMBER OF PROCESSOR UNITS
802
STORAGE SYSTEM
PROGRAM CODE
803
810
POWER SUPPLY
804
DATA INTERFACE
806
POWER INTERFACE
808
NUMBER OF LEVELS OF SECURITY
812

FIG. 9



900
TRAINING SYSTEM
REMOTE COMPUTER SYSTEM
926
LEARNING MANAGEMENT SYSTEM
LEARNING RECORD SYSTEM
928
922
920
WIRELESS COMMUNICATIONS LINK
924
DATA
930
REPORT
INFORMATION
OWNSHIP DATA
942
951
914
LIVE OBJECTS
902
AIRCRAFT
NETWORK INTERFACE
952
SENSOR SYSTEM
LIVE SENSOR DATA
950
956
918
NUMBER OF OPERATIONS
904
CREW
OPERATOR
944
960
WIRELESS COMMUNICATIONS LINK
INTERFACE
936
906
COMPUTER SYSTEM
AIRCRAFT NETWORK
DISPLAY SYSTEM
908
910
POD
934
NETWORK INTERFACE
962
958
PERFORMANCE
TRAINING PROCESSOR
932
SIMULATED OBJECTS
912
954
SIMULATION SENSOR DATA
SIMULATION
916
946
CONSTRUCTIVE DATA
NUMBER OF SIMULATION PROGRAMS
940
938
TRAINING SOFTWARE
948
VIRTUAL DATA



932
TRAINING PROCESSOR
FEEDBACK
1016
EVALUATION
1018
INSTRUCTIONS
1002
COMMUNICATIONS
1014
1020
AUDIO COMMUNICATIONS
1022
VIDEO COMMUNICATIONS
REPORT
PERFORMANCE
958
930
1000
VIRTUAL INSTRUCTOR
1004
ASSESSMENT MODULE
POLICY
SET OF RULES
1010
SIMULATION COMMANDS
INSTRUCTOR MODULE
EVENTS
1024
1006
1012
1008
SIMULATED OBJECTS
SIMULATION
916
912
954
SIMULATION SENSOR DATA
946
1026
CONSTRUCTIVE DATA
SET OF PARAMETERS
TRAINING SOFTWARE
NUMBER OF SIMULATION PROGRAMS
940
948
938
VIRTUAL DATA

FIG. 10

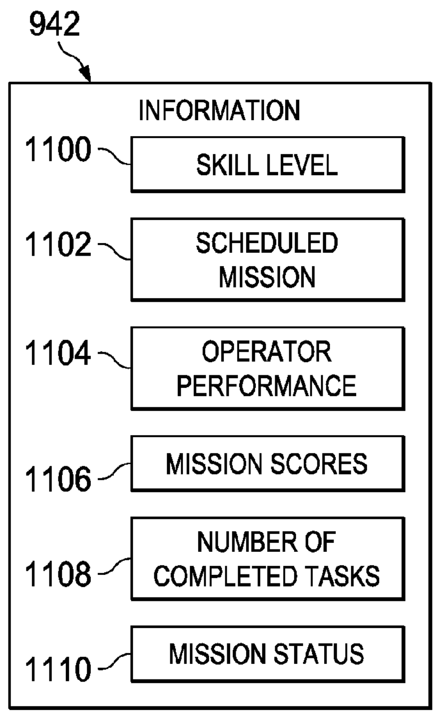

942
INFORMATION
1100
SKILL LEVEL
1102
SCHEDULED MISSION
1104
OPERATOR PERFORMANCE
1106
MISSION SCORES
1108
NUMBER OF COMPLETED TASKS
1110
MISSION STATUS

FIG. 11

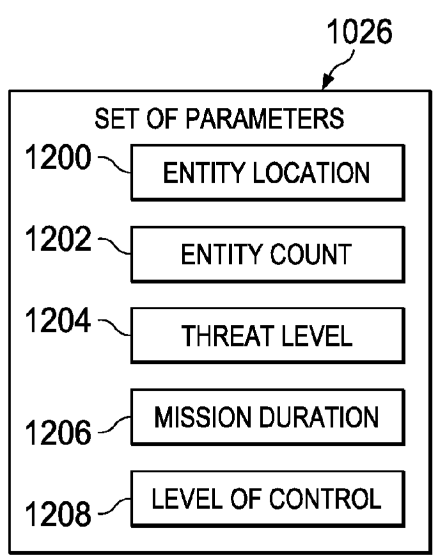

1026
SET OF PARAMETERS
1200
ENTITY LOCATION
1202
ENTITY COUNT
1204
THREAT LEVEL
1206
MISSION DURATION
1208
LEVEL OF CONTROL

FIG. 12

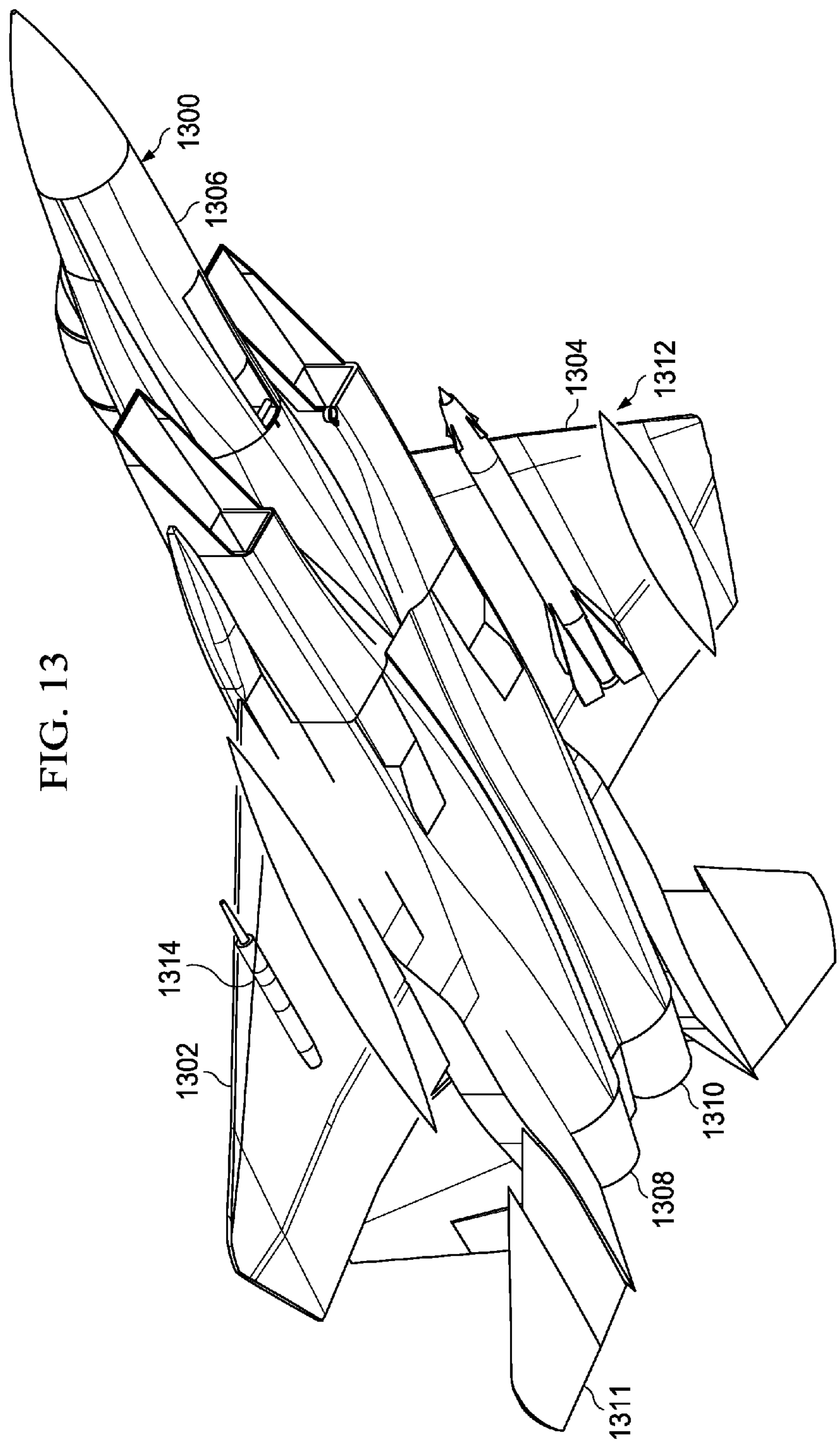


FIG. 13

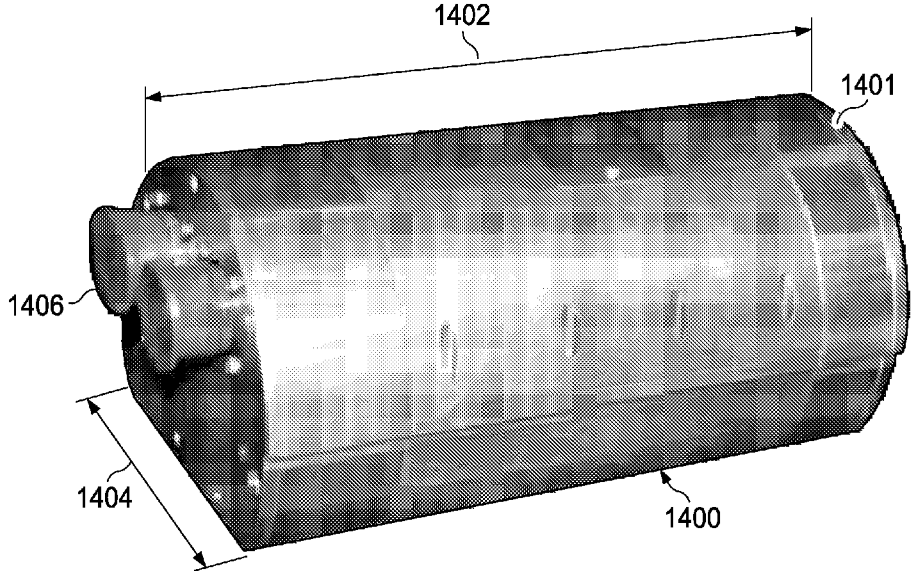


FIG. 14

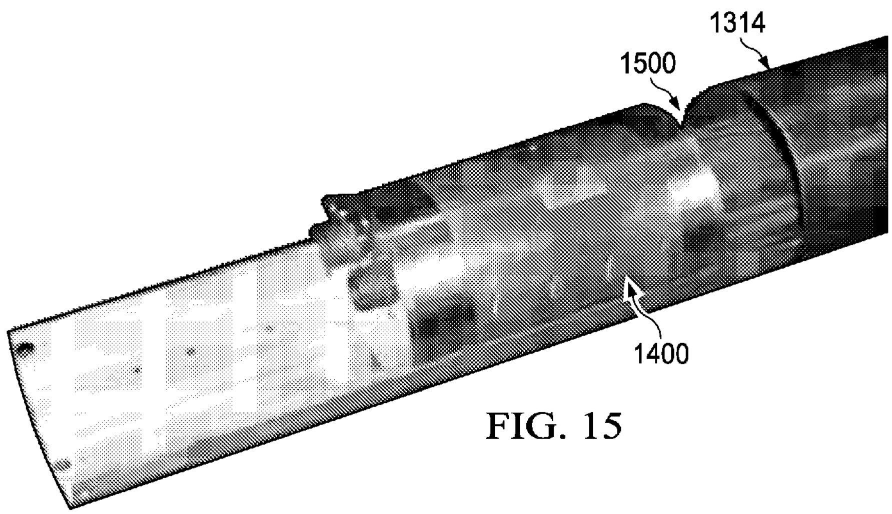


FIG. 15

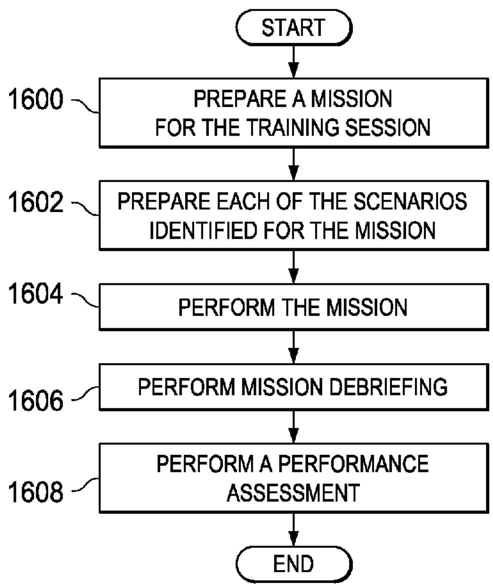

START
1600
PREPARE A MISSION FOR THE TRAINING SESSION
1602
PREPARE EACH OF THE SCENARIOS IDENTIFIED FOR THE MISSION
1604
PERFORM THE MISSION
1606
PERFORM MISSION DEBRIEFING
1608
PERFORM A PERFORMANCE ASSESSMENT
END

FIG. 16

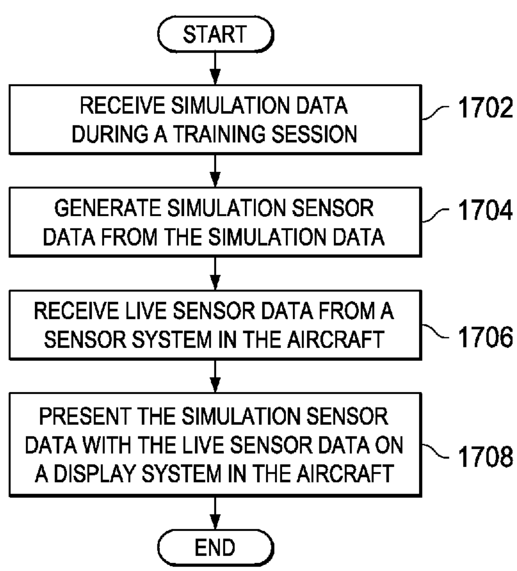

START
RECEIVE SIMULATION DATA DURING A TRAINING SESSION
1702
GENERATE SIMULATION SENSOR DATA FROM THE SIMULATION DATA
1704
RECEIVE LIVE SENSOR DATA FROM A SENSOR SYSTEM IN THE AIRCRAFT
1706
PRESENT THE SIMULATION SENSOR DATA WITH THE LIVE SENSOR DATA ON A DISPLAY SYSTEM IN THE AIRCRAFT
1708
END

FIG. 17

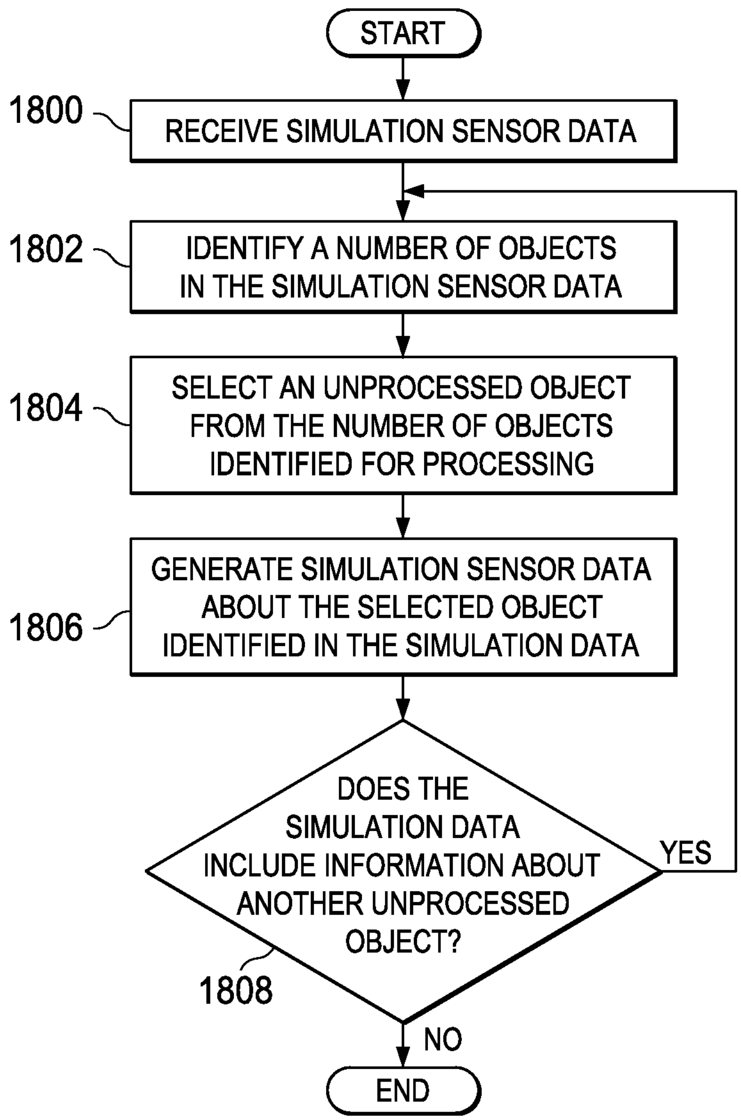

START
1800
RECEIVE SIMULATION SENSOR DATA
1802
IDENTIFY A NUMBER OF OBJECTS IN THE SIMULATION SENSOR DATA
1804
SELECT AN UNPROCESSED OBJECT FROM THE NUMBER OF OBJECTS IDENTIFIED FOR PROCESSING
1806
GENERATE SIMULATION SENSOR DATA ABOUT THE SELECTED OBJECT IDENTIFIED IN THE SIMULATION DATA
DOES THE SIMULATION DATA INCLUDE INFORMATION ABOUT ANOTHER UNPROCESSED OBJECT?
YES
1808
NO
END

FIG. 18

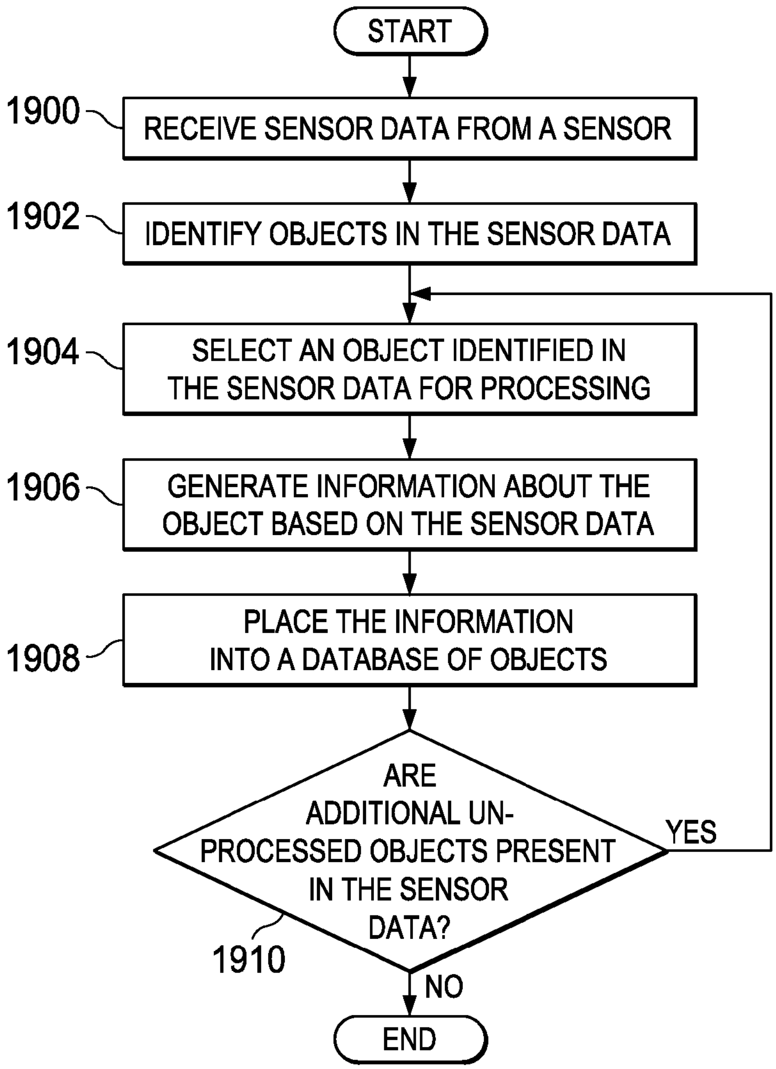

START
1900
RECEIVE SENSOR DATA FROM A SENSOR
1902
IDENTIFY OBJECTS IN THE SENSOR DATA
1904
SELECT AN OBJECT IDENTIFIED IN THE SENSOR DATA FOR PROCESSING
1906
GENERATE INFORMATION ABOUT THE OBJECT BASED ON THE SENSOR DATA
1908
PLACE THE INFORMATION INTO A DATABASE OF OBJECTS
ARE ADDITIONAL UN-PROCESSED OBJECTS PRESENT IN THE SENSOR DATA?
YES
1910
NO
END

FIG. 19

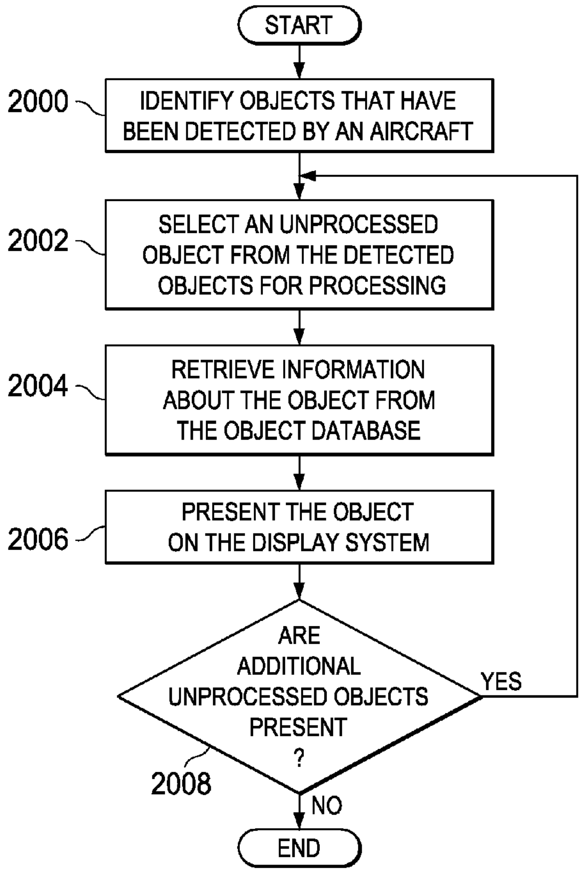

START
2000
IDENTIFY OBJECTS THAT HAVE BEEN DETECTED BY AN AIRCRAFT
2002
SELECT AN UNPROCESSED OBJECT FROM THE DETECTED OBJECTS FOR PROCESSING
2004
RETRIEVE INFORMATION ABOUT THE OBJECT FROM THE OBJECT DATABASE
2006
PRESENT THE OBJECT ON THE DISPLAY SYSTEM
ARE ADDITIONAL UNPROCESSED OBJECTS PRESENT ?
2008
YES
NO
END

FIG. 20

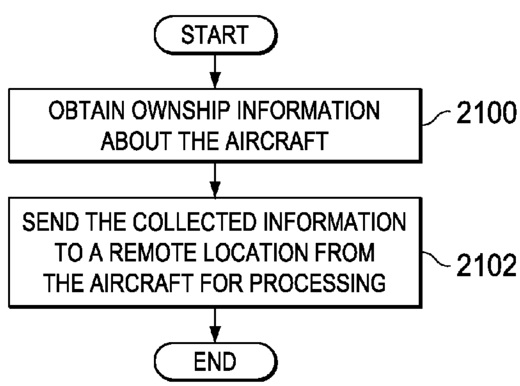

START
OBTAIN OWNSHIP INFORMATION ABOUT THE AIRCRAFT
2100
SEND THE COLLECTED INFORMATION TO A REMOTE LOCATION FROM THE AIRCRAFT FOR PROCESSING
2102
END

FIG. 21

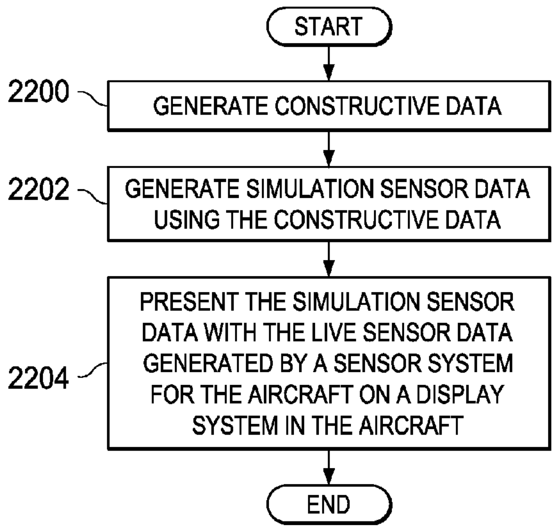

START
2200
GENERATE CONSTRUCTIVE DATA
2202
GENERATE SIMULATION SENSOR DATA USING THE CONSTRUCTIVE DATA
2204
PRESENT THE SIMULATION SENSOR DATA WITH THE LIVE SENSOR DATA GENERATED BY A SENSOR SYSTEM FOR THE AIRCRAFT ON A DISPLAY SYSTEM IN THE AIRCRAFT
END

FIG. 22

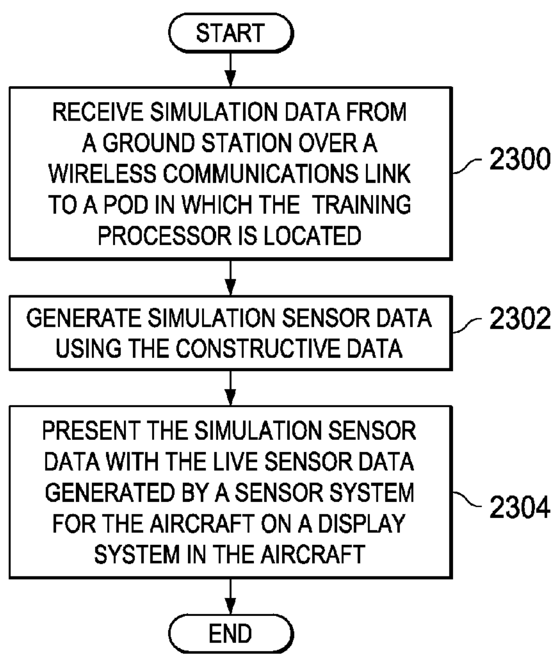

START
RECEIVE SIMULATION DATA FROM A GROUND STATION OVER A WIRELESS COMMUNICATIONS LINK TO A POD IN WHICH THE TRAINING PROCESSOR IS LOCATED
2300
GENERATE SIMULATION SENSOR DATA USING THE CONSTRUCTIVE DATA
2302
PRESENT THE SIMULATION SENSOR DATA WITH THE LIVE SENSOR DATA GENERATED BY A SENSOR SYSTEM FOR THE AIRCRAFT ON A DISPLAY SYSTEM IN THE AIRCRAFT
2304
END

FIG. 23

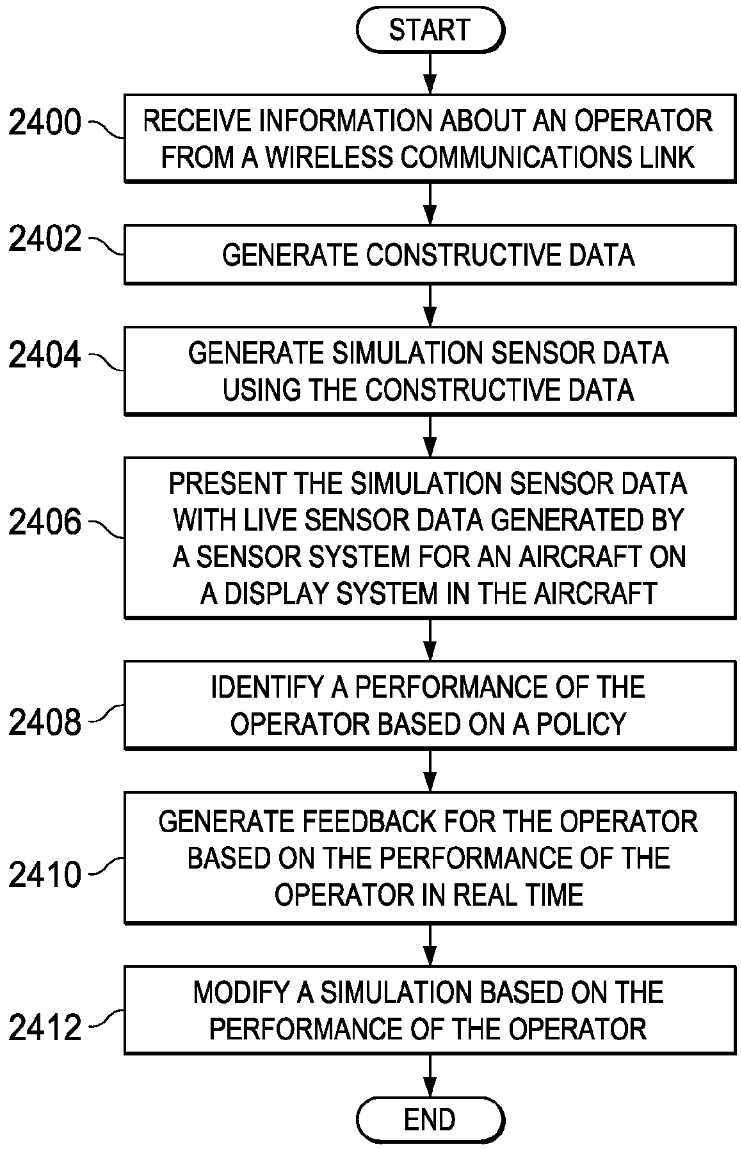

START
2400
RECEIVE INFORMATION ABOUT AN OPERATOR FROM A WIRELESS COMMUNICATIONS LINK
2402
GENERATE CONSTRUCTIVE DATA
2404
GENERATE SIMULATION SENSOR DATA USING THE CONSTRUCTIVE DATA
2406
PRESENT THE SIMULATION SENSOR DATA WITH LIVE SENSOR DATA GENERATED BY A SENSOR SYSTEM FOR AN AIRCRAFT ON A DISPLAY SYSTEM IN THE AIRCRAFT
2408
IDENTIFY A PERFORMANCE OF THE OPERATOR BASED ON A POLICY
2410
GENERATE FEEDBACK FOR THE OPERATOR BASED ON THE PERFORMANCE OF THE OPERATOR IN REAL TIME
2412
MODIFY A SIMULATION BASED ON THE PERFORMANCE OF THE OPERATOR
END

FIG. 24

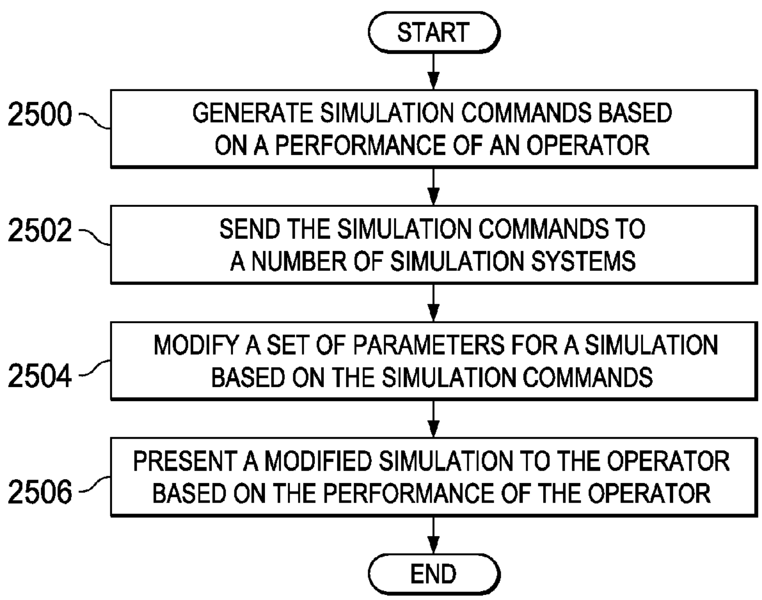

START
2500
GENERATE SIMULATION COMMANDS BASED ON A PERFORMANCE OF AN OPERATOR
2502
SEND THE SIMULATION COMMANDS TO A NUMBER OF SIMULATION SYSTEMS
2504
MODIFY A SET OF PARAMETERS FOR A SIMULATION BASED ON THE SIMULATION COMMANDS
2506
PRESENT A MODIFIED SIMULATION TO THE OPERATOR BASED ON THE PERFORMANCE OF THE OPERATOR
END

FIG. 25

PERFORMANCE-BASED SIMULATION SYSTEM FOR AN AIRCRAFT

CROSS-REFERENCES TO RELATED APPLICATION

This application is a continuation-in-part of patent application U.S. Ser. No. 13/304,514, filed Nov. 25, 2011, entitled "Integrated Live and Simulation Environment System for an Aircraft," which is a continuation-in-part of patent application U.S. Ser. No. 12/628,831, filed Dec. 1, 2009, entitled "Integrated Live and Simulation Environment System for an Aircraft." Both applications are incorporated herein by reference.

BACKGROUND INFORMATION

1. Field

The present disclosure relates generally to aircraft and, in particular, to a method and apparatus for performing training exercises in an aircraft. Still more particularly, the present disclosure relates to a method and apparatus for performing training exercises in an aircraft in which a live environment and a simulation environment are present.

2. Background

Training exercises are often performed for military aircraft. These training exercises are used to teach pilots how to operate the aircraft. Additionally, the exercises are also used to train the pilots on different strategies and tactics with respect to operating the aircraft. For example, pilots may train in an aircraft to improve skills and reactions to adversarial events. These events may include, for example, without limitation, encountering enemy aircraft, reacting to a presence of surface-to-air missile sites, engaging time sensitive targets, and other suitable events.

A large amount of training may be performed using training devices on the ground. These training devices often take the form of flight simulators. A flight simulator is a system that copies or simulates the experience of flying an aircraft. A flight simulator is meant to make the experience as real as possible. Flight simulators may range from controls and a display in a room to a full-size replica of a cockpit mounted on actuators that are configured to move the cockpit in response to actions taken by a pilot. These types of simulators provide a capability to teach pilots and/or other crew members to operate various aircraft systems and to react to different events.

Additional training is performed through training exercises using live aircraft. These types of training exercises expose pilots to the actual conditions encountered when flying an aircraft. Various conditions cannot be accurately simulated using a flight simulator. For example, the actual movement or forces encountered in flying an aircraft may not be adequately provided through a flight simulator.

With military aircraft, this type of training is typically performed on various areas or ranges. This type of training may involve using multiple live aircraft to perform training on encountering enemy aircraft. Further, various ground platforms also may be used. These ground platforms may include, for example, without limitation, tanks, surface-to-air missile systems, and other suitable ground units. These types of training exercises provide a pilot with the additional experience needed to operate an aircraft in different conditions.

Live training exercises are difficult and/or expensive to set up and operate. For example, to perform a training exercise in the air, airspace is restricted to other aircraft to avoid unintended incursions into the airspace in which the training

occurs. Additionally, fuel, maintenance, and other expenses are required to prepare the aircraft for the exercises, operate the aircraft during the exercises, and perform maintenance after the exercises have concluded.

Further, the amount of airspace may be confining and may restrict the type and amount of movement that aircraft can make during a training exercise. Times and locations where airspace can be restricted may limit the amount of time when training exercises can be performed. Therefore, it would be desirable to have a method and apparatus that take into account one or more of the issues discussed above as well as possibly other issues.

SUMMARY

In one illustrative embodiment, an apparatus comprises an aircraft, a display system associated with the aircraft, a sensor system associated with the aircraft, and a training processor configured to be connected to the aircraft. The training processor is further configured to receive information about an operator, generate constructive data for simulated objects, generate simulation sensor data using the constructive data, and present the simulation sensor data with live sensor data generated by the sensor system on the display system. The training processor is further configured to identify a performance of the operator based on a policy and modify a simulation based on the performance of the operator.

In another illustrative embodiment, a training system comprises a training processor configured to be connected to an aircraft. The training processor is further configured to receive information about an operator, generate constructive data for simulated objects, generate simulation sensor data using the constructive data, and present the simulation sensor data with live sensor data generated by a sensor system for the aircraft on a display system in the aircraft. The training processor is further configured to identify a performance of the operator based on a policy and modify a simulation based on the performance of the operator.

In yet another illustrative embodiment, a method for training in an aircraft is provided. Information about an operator is received from a wireless communications link. Constructive data is generated by a training processor. Simulation sensor data is generated by the training processor using the constructive data. The simulation sensor data is presented by the training processor with live sensor data generated by a sensor system for the aircraft on a display system in the aircraft. A performance of the operator is identified by the training processor based on a policy. A simulation is modified by the training processor based on the performance of the operator.

The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives, and descriptions thereof will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

FIG. **1** is an illustration of a block diagram of a training environment in accordance with an illustrative embodiment;

FIG. **2** is an illustration of a data processing system in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **3** is an illustration of a training environment in accordance with an illustrative embodiment;

FIG. **4** is an illustration of training software in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **5** is an illustration of data flow in a training environment in accordance with an illustrative embodiment;

FIG. **6** is an illustration of data flow in a training environment in accordance with an illustrative embodiment;

FIG. **7** is an illustration of a training system in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **8** is an illustration of a training processor in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **9** is an illustration of a training system in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **10** is an illustration of a training processor in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **11** is an illustration of information about an operator in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **12** is an illustration of a set of parameters for a simulation in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **13** is an illustration of an aircraft in accordance with an illustrative embodiment;

FIG. **14** is an illustration of a training processor in accordance with an illustrative embodiment;

FIG. **15** is an illustration of a training processor in a pod in accordance with an illustrative embodiment;

FIG. **16** is an illustration of a flowchart of a process for performing a training session in accordance with an illustrative embodiment;

FIG. **17** is an illustration of a flowchart of a process for training in an aircraft in accordance with an illustrative embodiment;

FIG. **18** is an illustration of a flowchart of a process for generating simulation sensor data received in an aircraft in accordance with an illustrative embodiment;

FIG. **19** is an illustration of a flowchart of a process for generating information about objects detected by sensors in accordance with an illustrative embodiment;

FIG. **20** is an illustration of a flowchart of a process for presenting object information in accordance with an illustrative embodiment;

FIG. **21** is an illustration of a flowchart of a process for sending data during a training session in accordance with an illustrative embodiment;

FIG. **22** is an illustration of a flowchart of a process for training in an aircraft in accordance with an illustrative embodiment;

FIG. **23** is an illustration of a flowchart of a process for training in an aircraft with a training processor in accordance with an illustrative embodiment;

FIG. **24** is an illustration of a flowchart of a process for training in an aircraft in accordance with an illustrative embodiment; and

FIG. **25** is an illustration of a flowchart of a process for modifying a simulation in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

The different illustrative embodiments recognize and take into account a number of considerations. For example, the different illustrative embodiments recognize and take into account that one manner in which training may be performed to reduce the expense and cost involves attaching pods or associating systems with the aircraft that simulate live platforms. These pods may include the hardware and software to simulate the platforms that the pilot may target or interact with.

This type of training simulates weapons that allow aircraft to target live platforms with onboard sensors. These pods also allow weapons to be shot through simulations embedded in the pods. The different illustrative embodiments recognize and take into account that this current type of simulation uses actual hardware or hardware emulations. A hardware emulation is hardware that takes a different form or type from the hardware actually used. A hardware emulation is configured to provide the same response or output as the actual hardware that is being emulated.

Although these types of systems may be useful, the different illustrative embodiments recognize and take into account that the hardware used for this type of simulation may have an undesired level of expense and maintenance.

Thus, the different illustrative embodiments provide a method and apparatus for integrating both live and simulation environments on an aircraft. The different illustrative embodiments provide a pilot and other crew members the capability to train in an actual training environment. This training environment includes both live and simulation objects. Data for the simulation objects is transmitted from other vehicles in the air or on the ground. In one illustrative embodiment, an apparatus comprises an aircraft, a network interface, a display system, a sensor system, and a computer system.

The network interface is configured to exchange data with a number of remote locations using a wireless communications link. The computer system is configured to run a number of processes to receive simulation data received through the network interface over the wireless communications link. The computer system is also configured to run a number of processes to receive live data from the sensor system. The computer system is configured to run a number of processes to present the simulation data with the live data on the display system in the aircraft.

In the different illustrative examples, the simulation data received from the network interface is processed to generate simulation sensor data. This simulation sensor data has the same format as sensor data generated by the sensor system associated with the aircraft. The simulation sensor data is processed by a number of processes running on the computer system to generate the sensor data. In these examples, the processes may take the form of a number of models for the different sensors in the sensor system. Some or all of the sensors may be modeled in these examples.

The sensor data generated by the models may be referred to as simulation sensor data. The sensor data generated by the sensor system may be referred to as live sensor data. The live sensor data and the simulation sensor data are presented together during the training session.

With reference now to FIG. **1**, an illustration of a block diagram of a training environment is depicted in accordance with an illustrative embodiment. In this illustrative example, training environment **100** includes vehicle **102**. Vehicle **102** takes the form of aircraft **104** in these depicted examples. Training session **106** may be performed using aircraft **104**, in which simulation environment **108** and live environment **110** are both present in training environment **100**.

In this illustrative example, network interface **112**, display system **114**, sensor system **116**, and computer system **118** are associated with aircraft **104**. A first component may be considered to be associated with a second component by being secured to the second component, bonded to the second component, fastened to the second component, and/or connected to the second component in some other suitable manner. The first component also may be connected to the second component by using a third component. The first component also may be considered to be associated with the second component by being formed as part of and/or an extension of the second component.

Computer system **118** comprises number of computers **119** in this illustrative example. Number of computers **119** may be in communication with each other using wired or wireless communications links in these illustrative examples. Training software **120** runs on number of computers **119** in these illustrative examples. Sensor system **116** generates live sensor data **121**. Simulation data **122** is received by network interface **112** over wireless communications link **124**.

In these illustrative examples, simulation data **122** may be for number of simulation objects **125**. In these illustrative examples, a simulation object is an object created by a computer program or an object represented by a training device. In other words, a simulation object is not a physical object in these examples.

In these illustrative examples, live sensor data **121** is data generated by sensor system **116** associated with aircraft **104** detecting number of live objects **126** in training environment **100**. A live object, as used in these illustrative examples, is a physical or real object. In other words, a live object can be seen, touched, and/or handled. For example, when the live object is an aircraft, the live object is the actual aircraft and not a computer representation of the aircraft or a training device for the aircraft. As used herein, a number of, where referring to items, means one or more items. For example, number of live objects **126** is one or more live objects. In these illustrative examples, number of live objects **126** is detected by number of sensors **128** within sensor system **116**.

In these illustrative examples, computer system **118** is configured to run training software **120** during training session **106** using aircraft **104** in these examples. Computer system **118** is configured to run training software **120** in a manner that presents live sensor data **121** and simulation data **122** together on display system **114**. In these illustrative examples, training software **120** generates simulation sensor data **123** using simulation data **122** in presenting simulation sensor data **123**. As a result, simulation sensor data **123** and live sensor data **121** may be processed to generate information about objects that are live and simulated. In other words, live sensor data **121** may be used to generate information about live objects. Simulation sensor data **123** may be used to generate information about objects that are only simulated and not physically present.

In these illustrative examples, simulation data **122** is data generated by a program running on a computer system or by a training device. For example, training environment **100** also may include at least one of number of simulation programs **130**, number of training devices **132**, and other suitable systems configured to generate simulation data **122**.

As used herein, the phrase "at least one of", when used with a list of items, means that different combinations of one or more of the listed items may be used and only one of each item in the list may be needed. For example, "at least one of item A, item B, and item C" may include, for example, without limitation, item A or item A and item B. This example also may include item A, item B, and item C, or item B and item C.

In these examples, number of simulation programs **130** generates simulation data **122** in the form of constructive data **134**. Constructive data **134** is data generated by a software program to simulate an object. The object may be, for example, without limitation, an aircraft, a ground vehicle, a missile site, a missile, or some other suitable object.

Number of training devices **132** generates virtual data **136** in simulation data **122**. Virtual data **136** is any data generated through the use of number of training devices **132**. Number of training devices **132** is any device that may be operated by a human operator. In these illustrative examples, number of training devices **132** may take the form of number of flight simulators **138**. In this example, number of flight simulators **138** may be used to generate number of simulation objects **125**. Number of simulation objects **125** may be fighter aircraft, transport aircraft, or other suitable types of aircraft in these examples.

In these illustrative examples, computer system **140** comprises number of computers **142**. Number of simulation programs **130** may run on one or more of number of computers **142**. In these illustrative examples, number of training devices **132** is in communication with computer system **140**. Number of training devices **132** sends virtual data **136** to computer system **140**. Computer system **140** takes constructive data **134** and virtual data **136** and sends this data as simulation data **122** to computer system **118** in aircraft **104**. Simulation data **122** may include information about simulation objects. For example, simulation data **122** may include information identifying a location of a simulation object, a heading of a simulation object, an identification of a simulation object, and other suitable information.

In these illustrative examples, computer system **118** also may generate ownship data **144**. Ownship data **144** is data describing aircraft **104**. Ownship data **144** is sent to computer system **140** over wireless communications link **124** through network interface **112**. Ownship data **144** may include, for example, at least one of a position of aircraft **104**, a speed of aircraft **104**, and other suitable data. Ownship data **144** also may include, for example, data indicating that number of weapons **150** have been fired on aircraft **104**. The firing of number of weapons **150** is simulated and not actual firings of number of weapons **150**. Simulation data **148** includes information about the firing of number of weapons **150**.

Computer system **140** receives ownship data **144**. Ownship data **144** is used by number of simulation programs **130** and number of training devices **132** to perform training session **106**. In these illustrative examples, ownship data **144** is used to represent aircraft **104** as an object in a simulation. Ownship data **144** allows other aircraft, vehicles, and/or objects to interact with aircraft **104** in the simulation. For example, ownship data **144** may be used by number of simulation programs **130** and number of training devices **132** to identify a location of aircraft **104**. This information may be used to determine how number of simulation objects **125** in the simulation interacts with aircraft **104**. In other words, ownship data **144** may be used to generate a simulation object for aircraft **104** that can be used within number of simulation programs **130** and/or by number of training devices **132**.

In these illustrative examples, training session **106** may be performed while aircraft **104** is in flight **152** and/or on ground **154**. In some illustrative embodiments, all of training session **106** for a particular exercise may be performed on ground **154**. In some illustrative embodiments, some events may occur while aircraft **104** is on ground **154** prior to taking off in flight **152**.

The illustration of training environment **100** in FIG. **1** is not meant to imply physical or architectural limitations to the manner in which different illustrative embodiments may be implemented. Other components in addition to and/or in place of the ones illustrated may be used. Some components may be unnecessary in some illustrative embodiments. Also, the blocks are presented to illustrate some functional components. One or more of these blocks may be combined and/or divided into different blocks when implemented in different illustrative embodiments.

For example, in some illustrative embodiments, additional aircraft, in addition to aircraft **104**, may be present in training environment **100** for performing training session **106**. In yet other illustrative embodiments, number of training devices **132** may be unnecessary with only number of simulation programs **130** being used.

In these illustrative examples, simulation sensor data **123** may be generated in a location other than computer system **118** in aircraft **104**. For example, a portion of training software **120** may run on a computer on the ground and generate the simulation sensor data. Simulation sensor data **123** may be transmitted over wireless communications link **124** to network interface **112** in place of or in addition to simulation data **122**.

Turning now to FIG. **2**, an illustration of a data processing system is depicted in the form of a block diagram in accordance with an illustrative embodiment. Data processing system **200** is an example of a data processing system that may be used to implement computers, such as number of computers **119** in computer system **118** and number of computers **142** in computer system **140** in FIG. **1**. In this illustrative example, data processing system **200** includes communications fabric **202**, which provides communications between processor unit **204**, memory **206**, persistent storage **208**, communications unit **210**, input/output (I/O) unit **212**, and display **214**.

Processor unit **204** serves to execute instructions for software that may be loaded into memory **206**. Processor unit **204** may be a set of one or more processors or may be a multi-processor core, depending on the particular implementation. Further, processor unit **204** may be implemented using one or more heterogeneous processor systems, in which a main processor is present with secondary processors on a single chip. As another illustrative example, processor unit **204** may be a symmetric multi-processor system containing multiple processors of the same type.

Memory **206** and persistent storage **208** are examples of storage devices **216**. A storage device is any piece of hardware that is capable of storing information, such as, for example, without limitation, data, program code in functional form, and/or other suitable information either on a temporary basis and/or a permanent basis. Memory **206**, in these examples, may be, for example, a random access memory or any other suitable volatile or non-volatile storage device.

Persistent storage **208** may take various forms, depending on the particular implementation. For example, persistent storage **208** may contain one or more components or devices. For example, persistent storage **208** may be a hard drive, a flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **208** may be removable. For example, a removable hard drive may be used for persistent storage **208**.

Communications unit **210**, in these examples, provides for communication with other data processing systems or devices. In these examples, communications unit **210** is a network interface card. Communications unit **210** may provide communications through the use of either or both physical and wireless communications links.

Input/output unit **212** allows for the input and output of data with other devices that may be connected to data processing system **200**. For example, input/output unit **212** may provide a connection for user input through a keyboard, a mouse, and/or some other suitable input device. Further, input/output unit **212** may send output to a printer. Display **214** provides a mechanism to display information to a user.

Instructions for the operating system, applications, and/or programs may be located in storage devices **216**, which are in communication with processor unit **204** through communications fabric **202**. In these illustrative examples, the instructions are in a functional form on persistent storage **208**. These instructions may be loaded into memory **206** for execution by processor unit **204**. The processes of the different embodiments may be performed by processor unit **204** using computer implemented instructions, which may be located in a memory, such as memory **206**.

These instructions are referred to as program code, computer usable program code, or computer readable program code that may be read and executed by a processor in processor unit **204**. The program code, in the different embodiments, may be embodied on different physical or computer readable storage media, such as memory **206** or persistent storage **208**.

Program code **218** is located in a functional form on computer readable media **220** that is selectively removable and may be loaded onto or transferred to data processing system **200** for execution by processor unit **204**. Program code **218** and computer readable media **220** form computer program product **222**. In one example, computer readable media **220** may be computer readable storage media **224** or computer readable signal media **226**.

Computer readable storage media **224** may include, for example, an optical or magnetic disk that is inserted or placed into a drive or other device that is part of persistent storage **208** for transfer onto a storage device, such as a hard drive, that is part of persistent storage **208**. Computer readable storage media **224** also may take the form of a persistent storage, such as a hard drive, a thumb drive, or a flash memory that is connected to data processing system **200**. In some instances, computer readable storage media **224** may not be removable from data processing system **200**.

Alternatively, program code **218** may be transferred to data processing system **200** using computer readable signal media **226**. Computer readable signal media **226** may be, for example, a propagated data signal containing program code **218**. For example, computer readable signal media **226** may be an electromagnetic signal, an optical signal, and/or any other suitable type of signal. These signals may be transmitted over communications links, such as wireless communications links, an optical fiber cable, a coaxial cable, a wire, and/or any other suitable type of communications link. In other words, the communications link and/or the connection may be physical or wireless in the illustrative examples.

In some illustrative embodiments, program code **218** may be downloaded over a network to persistent storage **208** from another device or data processing system through computer readable signal media **226** for use within data processing system **200**. For instance, program code stored in computer readable storage media in a server data processing system may be downloaded over a network from the server to data processing system **200**. The data processing system providing program code **218** may be a server computer, a client computer, or some other device capable of storing and transmitting program code **218**.

The different components illustrated for data processing system **200** are not meant to provide architectural limitations to the manner in which different embodiments may be implemented. The different illustrative embodiments may be implemented in a data processing system including components in addition to or in place of those illustrated for data processing system **200**.

Other components shown in FIG. **2** can be varied from the illustrative examples shown. The different embodiments may be implemented using any hardware device or system capable of executing program code. As one example, data processing system **200** may include organic components integrated with inorganic components and/or may be comprised entirely of organic components excluding a human being. For example, a storage device may be comprised of an organic semiconductor.

As one example, in some illustrative embodiments, display **214** may not be needed. In this type of implementation, data processing system **200** may be implemented as a server computer or line replaceable unit. A display may be unnecessary in this type of implementation. As another example, a storage device in data processing system **200** is any hardware apparatus that may store data. Memory **206**, persistent storage **208**, and computer readable media **220** are examples of storage devices in a tangible form.

In another example, a bus system may be used to implement communications fabric **202** and may be comprised of one or more buses, such as a system bus or an input/output bus. Of course, the bus system may be implemented using any suitable type of architecture that provides for a transfer of data between different components or devices attached to the bus system. Additionally, a communications unit may include one or more devices used to transmit and receive data, such as a modem or a network adapter. Further, a memory may be, for example, memory **206** or a cache such as found in an interface and memory controller hub that may be present in communications fabric **202**.

With reference now to FIG. **3**, an illustration of a training environment is depicted in accordance with an illustrative embodiment. In this illustrative example, training environment **300** is an example of one implementation for training environment **100** in FIG. **1**.

As depicted, training environment **300** includes network **302**, network **304**, aircraft **306**, and network server computer **308**. Network **302** includes gateway **310**, constructive server computer **312**, weapons server computer **314**, viewer server computer **318**, flight simulator **320**, and global positioning system receiver **322**. In these illustrative examples, network server computer **308** exchanges information with aircraft **306**. This exchange of information is performed using wireless communications link **324**.

Gateway **310** provides a connection between network server computer **308** and other components in network **302**. In other words, all information exchanged between network **302** and network server computer **308** flows through gateway **310**.

Constructive server computer **312** runs simulations of different objects. These different objects are simulation objects in these examples. For example, constructive server computer **312** may run simulations of other aircraft for the training involving aircraft **306**. As another example, constructive server computer **312** may run simulations to generate simulation objects, such as ground vehicles, ground stations, and other suitable objects.

Weapons server computer **314** runs processes to simulate the firing of weapons by aircraft **306**. The firing of weapons by aircraft **306**, in these examples, is simulation objects for the actual weapons. Weapons server computer **314** processes any indications of weapons fired by aircraft **306** to determine the direction and location of impact for the weapons.

Weapons server computer **314** simulates the weapon in flight and weapon detonation. Weapons server computer **314** publishes information about weapon type, position, velocity, acceleration, and state on network **302**. Additionally, weapons server computer **314** also may determine whether a particular object has been damaged or destroyed.

Viewer server computer **318** provides a capability to view the training that occurs. For example, viewer server computer **318** may display a map identifying the location of different objects including live and simulation objects. Further, viewer server computer **318** also may display results from weapons fire or other events. Viewer server computer **318** may be used during the training session to view events as they occur. Additionally, viewer server computer **318** may be used to provide a debriefing and analysis of the training session after the training session has completed.

In these illustrative examples, global positioning system receiver **322** is used within training environment **300** to create a common time source. Global positioning system receiver **322** may generate information about time. This common time source may be used by other computers and processes to synchronize the performance of different operations. Global positioning system receiver **322** is used to generate a common timestamp that is the same for the different components in training environment **300**.

Flight simulator **320** is a flight simulator that may be used to generate virtual data. The simulations performed using constructive server computer **312** and flight simulator **320** is sent through gateway **310** to network server computer **308**. The virtual data and the constructive data form simulation data for use by aircraft **306**.

Network server computer **308** sends the virtual data and the constructive data to aircraft **306**. Further, any data generated by aircraft **306** is returned through network server computer **308** over wireless communications link **324**. This information is then sent to network **302** for use by constructive server computer **312**, weapons server computer **314**, and flight simulator **320**.

In these illustrative examples, voice communications, such as those generated by operators of flight simulator **320** or generated by constructive server computer **312**, are sent to network **304**. In turn, network **304** sends these communications over radio frequency communications link **326** to aircraft **306** using radio frequency (RF) transmitter **328**.

The illustration of training environment **300** in FIG. **3** is not meant to imply physical or architectural limitations to the manner in which different illustrative embodiments may be implemented. This particular illustration is an example of one implementation of the manner in which training environment **100** in FIG. **1** may be implemented. In other illustrative embodiments, different components may be used in addition to or in place of the ones illustrated in these examples.

For example, the functions provided by the different server computers may be integrated into fewer numbers of computers or additional computers. In one example, the functions and processes for all of the different server computers illustrated in training environment **300** may be implemented on a single computer.

Further, flight simulator **320** may be a separate device from the computers running the servers in these examples. Flight simulator **320** may include a full-size replica of the cockpit for an operator.

With reference now to FIG. **4**, an illustration of training software is depicted in accordance with an illustrative embodiment. In this illustrative example, training software **400** is an example of one implementation for training software **120** in FIG. **1**. As illustrated, training software **400** runs on computer **402** during a training session. In the illustrative examples, training software **400** may be loaded onto computer **402** to run training exercises. Computer **402** may be implemented using data processing system **200** in FIG. **2** and is an example of one implementation for computer system **118** in FIG. **1**.

Training software **400** comprises number of processes **404**. Number of processes **404** may include number of sensor models **406**. As illustrated, number of processes **404** includes data process **412**, infrared targeting process **414**, and data collection process **416**. In these illustrative examples, number of processes **404** may process live sensor data **408** and simulation data **410**. Number of processes **404** receives simulation data **410** from network interface **420**.

Live sensor data **408** is received from sensor system **422**. Sensor system **422**, in these illustrative examples, may include at least one of radar system **426**, radar warning receiver **427**, infrared targeting pod **428**, global positioning system unit **430**, and other suitable components.

In these illustrative examples, number of processes **404** also may receive ownship data **462** from controls **432** and navigation system **433**. As depicted, controls **432** may comprise at least one of flight stick **434**, switches **435**, and other suitable controls that may be located within the aircraft. Navigation system **433** may include at least one of global positioning system unit **436**, inertial navigation system **437**, and other suitable types of systems.

In these depicted examples, number of processes **404** combine live sensor data **408** and simulation data **410** for presentation on display system **438**. Display system **438** may include, for example, number of video display devices **439** and number of audio devices **440**. Display system **438** is the display system used in the aircraft and does not require modifications in the different illustrative embodiments.

Number of sensor models **406** provides models of the physical sensors located in sensor system **422**. In these different illustrative embodiments, number of sensor models **406** processes simulation data **410** to generate simulation sensor data **447**.

Number of sensor models **406** includes radar model **442** and radar warning receiver model **444**. A model, in these illustrative examples, is a process that is designed to simulate a live or physical object. For example, radar model **442** is designed to simulate the operation of radar system **426**. Radar warning receiver model **444** is a process designed to simulate the operation of radar warning receiver **427**. Radar model **442** and radar warning receiver model **444** generate output that is the same or substantially the same as the output generated by radar system **426** and radar warning receiver **427**, respectively.

In this illustrative example, infrared targeting process **414** in number of processes **404** receives live sensor data **408** from infrared targeting pod **428**. Additionally, infrared targeting process **414** may receive information about objects in simulation data **410**. In this illustrative example, infrared targeting process **414** adds data to live sensor data **408** based on information in simulation data **410**. In this example, the data generated by infrared targeting process **414** also is part of simulation sensor data **447** in these examples. For example, infrared targeting process **414** may add symbols to live sensor data **408** from infrared targeting pod **428** to simulate various objects, such as aircraft, missiles, ground radar, and other objects.

Data process **412** in number of processes **404** receives simulation sensor data **447** and live sensor data **408**. In these illustrative examples, data process **412** generates live object data **446** and simulation object data **448**. Live object data **446** is information about real or physical objects detected by sensor system **422**. Simulation object data **448** also may be generated by infrared targeting process **414** processing live sensor data **408** to create simulation object data **448**.

Simulation object data **448** is information generated about simulation objects received in simulation sensor data **447**. This information may include, for example, without limitation, an identification of an object, a graphical identifier to use with the object, and other suitable information.

Also, in these different illustrative examples, simulation object data **448** may include identifiers or flags to indicate that the particular object is a simulation object and not a live or physical object. This information may be used to generate graphical indicators such that an operator can determine which objects are live or simulated. In these examples, the graphical indicators may be presented on number of video display devices **439** in display system **438**. Live object data **446** and simulation object data **448** form object database **450**.

In these illustrative examples, data process **412** generates live object data **446** from live sensor data **408** received from sensor system **422**. For example, objects detected by radar system **426** are identified and processed by data process **412**. Each identified object forms an object within live object data **446**.

In these illustrative examples, simulation data **410** may include identification **456**, position **458**, and heading **460** for a simulation object. Radar model **442** may use this information as input to generate simulation sensor data **447**. In a similar fashion, simulation data **410** may be processed by data process **412** using radar warning receiver model **444** to generate simulation sensor data **447** for the simulation object as being a friend or foe.

In these illustrative examples, data process **412** uses live object data **446** and simulation object data **448** in object database **450** as a single presentation on display system **438**. In other words, both live objects and simulation objects are presented and interacted with by an operator of the aircraft such that both live sensor data **408** and simulation data **410** are presented together in an integrated presentation.

In these illustrative examples, live object data **446** and simulation object data **448** may be presented on display system **438**. This information may be presented on number of video display devices **439** to provide an operator an indication of where different objects may be located relative to the aircraft. Further, number of audio devices **440** also may be used to present live object data **446** and simulation object data **448** from object database **450**. In some cases, audio warnings or messages may be presented based on information in object database **450**.

Data collection process **416** may receive ownship data **462** from controls **432** and from navigation system **433**. For example, data collection process **416** may receive an indication of a firing of a weapon in response to an activation of a control in controls **432**. Additionally, data collection process **416** receives position information from global positioning system unit **436** and inertial navigation system **437**.

This information is sent back as ownship data **462** to a remote location through network interface **420**. Ownship data **462** is used by simulation programs and training devices, such as number of simulation programs **130** and number of training devices **132** in FIG. **1**. Ownship data **462** may be used to represent the aircraft as an object within the simulations run by number of simulation programs **130** and number of training devices **132** in FIG. **1**.

The illustration of training software **400** in FIG. **4** is not meant to imply physical or architectural limitations to the manner in which different illustrative embodiments may be implemented. Other components in addition to and/or in place of the ones illustrated may be used. Some components may be unnecessary in some illustrative embodiments. Also, the blocks are presented to illustrate some functional components. One or more of these blocks may be combined and/or divided into different blocks when implemented in different illustrative embodiments.

For example, in some illustrative embodiments, some processes in number of processes **404** and number of sensor models **406** may run on a different computer, other than computer **402** in the aircraft. In yet other illustrative embodiments, number of sensor models **406** may be unnecessary if simulation data **410** includes simulation object data **448** for use by number of processes **404**. Simulation object data **448** may be sent as part of simulation data **410** if sufficient bandwidth is present for use by network interface **420**. In other words, the different models for the sensor system in the aircraft may be run in a remote location with that sensor data being sent to computer **402** for processing and presentation.

Object database **450** may be transmitted to a remote location using network interface **420** during the training. In some illustrative embodiments, object database **450** may be downloaded after the flight is completed. Object database **450** may be reviewed to evaluate the training that was performed.

As another example, although the illustrative example shows radar model **442** and radar warning receiver model **444**, other models also may be used in addition to or in place of the ones depicted. For example, these models may include an Interrogator Friend or Foe model, a chaff and flair dispenser model, an electronic warfare jamming model, and/or other suitable models.

With reference now to FIG. **5**, an illustration of data flow in a training environment is depicted in accordance with an illustrative embodiment. In this illustrative example, training environment **500** is an example of one implementation of training environment **100** in FIG. **1**. Further, training environment **500** may be implemented using training software **400** in FIG. **4**. The data flow illustrated in this example is for processing simulation data and live data for aerial objects that may be encountered by an aircraft.

As depicted, training environment **500** includes aircraft **501** and ground terminal **502**. Ground terminal **502** has computer system **503** for sending simulation data **504** to aircraft **501**. Simulation data **504** is sent using a wireless communications link in this illustrative example. Simulation data **504** is received by aircraft **501** using data link terminal **506**. Data link terminal **506** may take the form of an avionics device configured to generate and receive different types of data in these examples.

Data at data link terminal **506** is sent to data link report manager **507** running on computer system **505** in aircraft **501**. Data link report manager **507** identifies simulation data **504** received from data link terminal **506** and sends simulation data **504** to data processes **508** for processing. In these illustrative examples, data link terminal **506** and data link report manager **507** form a network interface, such as network interface **420** in FIG. **4**, between computer system **503** and computer system **505**.

Simulation data **504** is sent from data link report manager **507** to data link translator **509**. Data link translator **509** is a process in data collection process **416** in FIG. **4** in these illustrative examples. Data link translator **509** separates the simulation data into arrays of simulation data. A portion of these arrays of simulation data is sent into radar model **510**, and a portion of these arrays of simulation data is sent into radar warning receiver model **512**. The portion of the arrays of simulation data sent into radar model **510** may include information, such as, for example, simulation object information and/or other suitable information. The portion of the arrays of simulation data sent into radar warning receiver model **512** may include information, such as, for example, simulation information about radar emission sources external to aircraft **501**.

Radar model **510** generates simulation sensor data. This simulation sensor data is sent to simulation radar unpacker **514**. The simulation sensor data may have a format similar to or substantially the same as a format for radar system **518** in aircraft **501**. Simulation radar unpacker **514** changes the format of the simulation sensor data into a format for storage in object database **522**.

In this illustrative example, radar system **518** generates live radar data **519**. Live radar data **519** is sent to live radar unpacker **520** in data processes **508**. Live radar unpacker **520** changes the format of live radar data **519** into a format for storage in object database **522**. As depicted, both simulation radar unpacker **514** and live radar unpacker **520** send the data with the changed format to radar report manager **516**.

Radar report manager **516** identifies simulation object data and live object data for storage in object database **522** and then stores this data in object database **522**. Both the simulation object data and the live object data may have substantially the same format in these examples. In some illustrative embodiments, the simulation object data may be associated with an identifier to identify the data as simulation data and not live data.

The data stored in object database **522** may be sent to controls and display system **524**. In other words, an operator may control and view the simulation object data and live object data stored using controls and display system **524**.

In this depicted example, radar warning receiver model **512** generates simulation sensor data that is sent to simulation radar warning receiver unpacker **530**. Simulation radar warning receiver unpacker **530** changes the format of the simulation sensor data and sends the data with the changed format to controls and display system **524**. The format of the data is changed such that the data may be controlled and viewed using controls and display system **524**.

Controls and display system **524** may be implemented using controls **432** and/or display system **438** in FIG. **4**. Further, controls and display system **524** may display the simulation object data and live object data using display formats **532**. Display formats **532** may include, for example, without limitation, heads-up display formats, heads-down display formats, and/or other suitable types of formats.

In this illustrative example, an operator may send a request to request arbitrator **526** using controls and display system **524**. This request may be, for example, a request to change a component, data, or some other feature of radar model **510**. Request arbitrator **526** determines whether the request should be sent to radar model **510**. Request arbitrator **526** uses a set of rules and/or a set of priorities for operations performed by radar model **510** to determine whether the request should be sent to radar model **510**. As one illustrative example, if a request has a lower priority than an operation being performed by radar model **510**, the request is not sent to radar model **510** until the completion of the operation. If the request may be sent to radar model **510**, request arbitrator **526** sends the request to radar packer **528**. Radar packer **528** changes the format of the request into a format radar model **510** may process.

Data processed using data processes **508** also is sent back to ground terminal **502** from aircraft **501**. For example, weapons launch data **534** may be generated using the data presented using controls and display system **524**. Weapons launch data **534** is sent to data packer **540**. Data packer **540** also receives navigation data **537** generated by navigation system **536**.

Data packer **540** changes the format of the data into a format for transmission to computer system **503**. The data is sent to data link translator **509** along with simulation sensor data from radar model **510**. This data is then sent to data link report manager **507** and then to data link terminal **506**. The data is transmitted from data link terminal **506** to computer system **503** in ground terminal **502** using a wireless communications link.

With reference now to FIG. **6**, an illustration of data flow in a training environment is depicted in accordance with an illustrative embodiment. In this illustrative example, training environment **600** is an example of one implementation of training environment **100** in FIG. **1**. Further, training environment **600** may be implemented using training software **400** in FIG. **4**. The data flow illustrated in this example uses components and processes similar to the data flow illustrated in FIG. **5**. However, in this illustrative example, training environment **600** is for processing simulation data and live data for ground-based objects that may be encountered by an aircraft.

As depicted, training environment **600** includes aircraft **601** and ground terminal **602**. Ground terminal **602** has computer system **603** for sending simulation data **604** to aircraft **601**. Simulation data **604** is sent using a wireless communications link in this illustrative example. Simulation data **604** is received by aircraft **601** using data link terminal **606**. Data at data link terminal **606** is sent to data link report manager **607** running on computer system **605** in aircraft **601**. Data link report manager **607** identifies simulation data **604** received from data link terminal **606** and sends simulation data **604** to data processes **608** for processing.

Simulation data **604** is sent from data link report manager **607** to data link translator **609**. Data link translator **609** separates simulation data **604** into arrays of simulation data. A portion of these arrays of simulation data is sent into radar warning receiver model **610**. Another portion of these arrays of simulation data is sent to object position unpacker **612**.

The portion of arrays of simulation data sent to object position unpacker **612** contains position data for simulation objects. In this illustrative example, these simulation objects are ground-based objects. Object position unpacker **612** changes the format of the arrays of simulation data such that the position data for the simulation objects may be controlled and viewed using controls and display system **624**.

In this depicted example, radar warning receiver model **610** generates simulation sensor data from the arrays of simulation data. The simulation sensor data is sent to simulation radar warning receiver unpacker **614**. Simulation radar warning receiver unpacker **614** changes the format of the simulation sensor data and sends the data with the changed format to controls and display system **624**. The format of the data is changed such that the data may be controlled and viewed using controls and display system **624**.

In this illustrative example, an operator may use the position data for the simulation objects presented in controls and display system **624** to select a simulation object to be monitored using radar system **616**. The operator may send a request to request arbitrator **626** based on the selected simulation object. This request may be to change radar system **616** to map mode **618**. Map mode **618** allows radar system **616** to monitor a particular area based on the position data for the selected simulation object. In other words, map mode **618** allows radar system **616** to monitor an area for a simulation object without identifying the simulation object or the specific position of the simulation object.

Request arbitrator **626** determines whether this request should be sent to radar system **616**. This determination may be based on a set of rules and/or a set of priorities for operations performed by radar system **616**. If the request is sent to radar system **616**, request arbitrator **626** sends the request to radar packer **628**. Radar packer **628** changes the format of the request to a format that may be processed by radar system **616**. In this illustrative example, radar packer **628** changes the format of the request to a command that may be executed by radar system **616**.

In response to receiving the request with the changed format from radar packer **628**, radar system **616** changes to map mode **618** and sends live radar data **619** to live radar unpacker **620**. Live radar data **619** is a map of a particular area identified using the position data for the selected simulation object. Live radar unpacker **620** changes the format of live radar data **619** into a format for storage in object database **630**. As depicted, live radar unpacker **620** sends the data with the changed format to radar report manager **631**.

Further, request arbitrator **626** also sends data included in the request from the operator to radar report manager **631**. This data may include information identifying the selected simulation object and/or the position data for the simulation object. Radar report manager **631** identifies simulation object data and live object data for storage in object database **630** and then stores this data in object database **630**. In these illustrative examples, simulation object data and the live object data have substantially the same format.

The data stored in object database **630** is sent to controls and display system **624**. In other words, an operator may control and view the simulation object data and live object data stored using controls and display system **624**.

Controls and display system **624** displays the simulation object data and live object data using display formats **632**. Display formats **632** may include, for example, without limitation, heads-up display formats, heads-down display formats, and/or other suitable types of formats.

Data processed using data processes **608** also is sent back to ground terminal **602** from aircraft **601**. For example, weapons launch data **634** may be generated using the data presented using controls and display system **624**. Weapons launch data **634** is sent to data packer **640**. Data packer **640** also receives navigation data **637** generated by navigation system **636**. Further, data packer **640** receives live radar data **619** from radar system **616**. Data packer **640** changes the format of all the data received into a format for transmission to computer system **603**. The data is sent to data link translator **609**. This data is then sent to data link report manager **607** and then to data link terminal **606**. The data is transmitted from data link terminal **606** to computer system **603** in ground terminal **602** using a wireless communications link.

With reference now to FIG. **7**, an illustration of a training system is depicted in accordance with an illustrative embodiment. In this illustrative example, training system **700** includes aircraft **702**. Aircraft **702** is an example of an aircraft that may be used in training environment **100** in FIG. **1**. Aircraft **702** may be used in place of or in addition to aircraft **104** in FIG. **1**. Aircraft **702** may be used to train crew **703**. Crew **703** may be one or more human operators that operate aircraft **702**.

As depicted, aircraft **702** includes computer system **704**. Computer system **704** is comprised of number of computers **706** in this illustrative example. If more than one computer is present in number of computers **706**, those computers are in communication with each other using aircraft network **708**. Computer system **704** also includes display system **710**. Display system **710** comprises one or more display devices in aircraft **702**. In this implementation, computer system **704** takes the form of aircraft network data processing system **712**.

Aircraft **702** also has network interface **714**. Network interface **714** is configured to provide wireless communications link **716** with remote computer system **718**. Remote computer system **718** may be at a remote location on the ground in these illustrative examples.

In these illustrative examples, training processor **720** may be associated with aircraft **702**. As depicted, training processor **720** may be removably connected to aircraft **702**. Training processor **720** may be connected to aircraft **702** using interface **722**. Interface **722** may provide power and communications for training processor **720**. For example, interface **722** may be an interface to computer system **704** in aircraft **702**.

In these illustrative examples, training processor **720** may be internally or externally connected to aircraft **702**. In other words, training processor **720** may be located inside of or outside of aircraft **702**.

In one illustrative example, training processor **720** may be configured to be used in pod **724** for aircraft **702**. Training processor **720** may be placed into pod **724** or may be integrated as part of pod **724**.

Pod **724** is a structure configured to be connected to the exterior of aircraft **702**. In these illustrative examples, when training processor **720** is placed in pod **724**, interface **722** may be weapons bus **726** for aircraft **702**. As depicted, weapons bus **726** is an interface normally available on aircraft **702** for use with pods such as weapon pods. Weapons bus **726** may provide a connection between weapons and sensors in pod **724** connected to aircraft **702**. Of course, interface **722** may take other forms.

As depicted, training processor **720** takes the form of hardware and software. Training processor **720** includes training software **728** and number of simulation programs **730**. Training software **728** may be the same training software as training software **120** running on computer system **118** in aircraft **104** in FIG. **1**. Number of simulation programs **730** may be implemented using the same simulation programs as number of simulation programs **130** in computer system **140** in FIG. **1**. As can be seen, training processor **720** combines functions provided by computer system **118** and computer system **140** in this particular implementation.

In this depicted example, training processor **720** generates constructive data **732**. Constructive data **732** is for a number of simulation objects that are simulated for a particular training session. Constructive data **732** may be generated in place of or in addition to constructive data **134** generated by computer system **140** in FIG. **1**.

Further, training processor **720** also may receive virtual data **136** from number of training devices **132** in FIG. **1**. Virtual data **136** may be received over wireless communications link **716** for aircraft **702**. In some illustrative examples, pod **724** also may have network interface **733**. Network interface **733** may be used to establish wireless communications link **735** between pod **724** and a ground system, such as remote computer system **718**. With wireless communications link **735**, training processor **720** may receive virtual data **734** without using network interface **714** and wireless communications link **716**.

Virtual data **136** may be received directly from number of training devices **132** or from computer system **140**, depending on the particular implementation. In these illustrative examples, virtual data **136** forms virtual data **734** used by training processor **720**. Further, in some illustrative examples, training processor **720** also may receive live sensor data **736** generated by sensor system **738** associated with aircraft **702**.

In these illustrative examples, training processor **720** may operate in tethered mode **740** or untethered mode **742**. When operating in tethered mode **740**, training processor **720** may receive virtual data **136**. Further, training processor **720** also may receive constructive data **134** from number of simulation programs **130** in addition to generating constructive data **732**.

Training processor **720**, however, may still provide training for crew **703** even when wireless communications link **716** is absent or not usable by training processor **720**. In some cases, aircraft **702** may not be able to establish wireless communications link **716**. In still other illustrative examples, the amount of bandwidth available in wireless communications link **716** may preclude use of wireless communications link **716** by training processor **720**.

Further, in untethered mode **742**, training processor **720** may still use wireless communications link **735** to communicate with other aircraft using pods and training processors similar to pod **724** and training processor **720**. In this situation, communications with a ground system may be absent or unavailable. Aircraft in a training session, however, may still communicate with each other to form a virtual battle space through communications links between training processors in the aircraft. In other words, remote computer system **718** may be a training processor in another aircraft.

In operation, training processor **720** uses constructive data **732** to generate simulation sensor data **744**. Training processor **720** presents simulation sensor data **744** with live sensor data **736** generated by sensor system **738** on display system **710** in aircraft **702**. In these illustrative examples, training processor **720** may send simulation sensor data **744** to computer system **704** for display on display system **710**. Computer system **704** may receive live sensor data **736** and display live sensor data **736** with simulation sensor data **744**.

In other illustrative examples, training processor **720** may also receive live sensor data **736** for use in processing simulation sensor data **744**, generating constructive data **732**, or for some other purpose with respect to a training session.

Additionally, training processor **720** also may generate audio data **746**, video data **747**, or some combination thereof. Audio data **746** may be, for example, sounds to simulate operation of systems in aircraft **702**. The sounds may be, for example, sensor sounds, weapon sounds, and other suitable sounds.

Video data **747** may be displays generated for presentation in display system **710** in aircraft **702**. Video data **747** may be for a number of simulated objects. These displays may include three-dimensional graphics of simulated objects, such as targets, terrain, and other suitable objects.

Further, training processor **720** also may provide audio communications **748** with training devices over wireless communications link **735**. These training devices may be, for example, number of training devices **132** in FIG. **1**. Audio communications **748** may be implemented using different technologies such as voice over internet protocol (VoIP).

In these illustrative examples, computer system **704** is configured to receive simulation sensor data **744**, audio data **746**, video data **747**, audio communications **748**, and/or other data generated by training processor **720**. In other words, computer system **704** is configured to receive data from training processor **720** and display or otherwise present that data in computer system **704** to crew **703**. In particular, one or more operational flight programs in aircraft **702** may be configured to communicate with training processor **720**.

Turning now to FIG. **8**, an illustration of a training processor is depicted in accordance with an illustrative embodiment. In this illustrative example, training processor **720** comprises housing **800**, number of processor units **802**, storage system **803**, power supply **804**, data interface **806**, and power interface **808**.

Housing **800** is a physical structure configured to hold the different components for training processor **720**. As depicted, housing **800** is configured to be moveable. Housing **800** may have a shape and size configured for placement into pod **724** in FIG. **7**.

Each processor unit in number of processor units **802** may include one or more processors. These processors are configured to run program code **810** stored in storage system **803**. Program code **810** is program code for training software **728** and number of simulation programs **730** in FIG. **7**.

Storage system **803** comprises one or more storage devices. Storage system **803** may include, for example, at least one of a hard disk drive, a random access memory, a read only memory, a solid state drive, and other suitable types of storage devices.

Power supply **804** may receive and condition power received through interface **722**. For example, power supply **804** may provide filtering, voltage conversion, and other suitable types of power processing. Data interface **806** provides communication with aircraft network **708** through interface **722** in these illustrative examples.

In these illustrative examples, number of levels of security **812** may be provided for training processor **720**. Number of levels of security **812** may be provided through segregating processes in training software **728** and number of simulation programs **730**. For example, processes may be segregated to run only on processor units in number of processor units **802** having a desired security level. Security levels may include, for example, unclassified, controlled unclassified, confidential, secret, top secret, and other suitable types of security classifications. Of course, any type of classification may be used. In some cases, the security levels may merely be confidential and non-confidential.

With this implementation, number of processor units **802** may be located on different boards in training processor **720**. Further, storage devices in storage system **803** also may be distributed on these boards and may be accessible by only the processor unit on the same board as the storage device. In this manner, physical partitions may be present to provide desired security when number of levels of security **812** is present. This type of segregation may reduce maintenance and operational issues when different types of information and/or processes may be present that have different security levels.

Further, training processor **720** may be configured to self-heal or have fail-over capabilities in the event that some components fail within training processor **720**. In these illustrative examples, if a processor unit running a process in number of processor units **802** is failing to operate as desired, a portion of the other processor units in number of processor units **802** runs the processes for the processor unit that is failing to operate as desired.

For example, if a processor unit within number of processor units **802** fails, one or more of the remaining processor units take over running processes that were originally running on the failing processor unit. In these illustrative examples, number of processor units **802** may include extra or redundant processor units that are present in case one or more processor units in number of processor units **802** fails to operate as desired.

The illustration of training system **700** in FIG. **7** is not meant to imply physical or architectural limitations to the manner in which training system **700** may be implemented. Other components in addition to, or in place of, the ones illustrated may be used. Some components may be unnecessary. Also, the blocks are presented to illustrate some functional components. One or more of these blocks may be combined, divided, or combined and divided into different blocks when implemented in an illustrative embodiment.

For example, although training processor **720** has been described as being placed in pod **724** connected to aircraft **702**, training processor **720** may be configured for placement inside the cockpit of the aircraft, inside a fairing for an aircraft, mounted on a surface of the aircraft, or some other suitable location.

Thus, training processor **720** provides an ability to interject simulation data into computer system **704** to present simulated objects for training crew **703**. The presentation of simulated objects may occur in conjunction with live objects that may be around aircraft **702**.

In particular, training processor **720** allows for combining of constructive data **732** and/or virtual data **734** with live sensor data **736**. As discussed above, constructive data **732**, virtual data **734**, or both may be used to generate simulation sensor data **744** that may be displayed with live sensor data **736** on display system **710**.

In this manner, one or more illustrative embodiments provide an ability to train crew **703** in aircraft **702** using a system that is not integrated into computer system **704** of aircraft **702**. As depicted, training processor **720** is configured to be moveable and may be moved from one aircraft to another aircraft. This portability of training processor **720** may reduce costs and reduce the time needed to configure an aircraft for use in training.

Additionally, with training processor **720** being a separate component from computer system **704**, upgrades, modifications, and other changes to program code **810** in training processor **720** may be performed more often. In other words, changes to program code **810** or other components in training processor **720** may be made without waiting for upgrades or changes to operational flight programs in computer system **704** for aircraft **702**. In other words, changes to training processor **720** may occur without having to wait for or take into account cycles for changes to operational flight programs or other software in aircraft **702**.

The illustrative embodiments also recognize and take into account that feedback may be desirable for a training session. In particular, feedback about performance of an operator of an aircraft may be desirable. This operator may be, for example, without limitation, a pilot, copilot, a navigator, or some other operator of the aircraft. Further, the illustrative embodiments also recognize and take account that providing this feedback may desirable during performance of a training session.

Additionally, the illustrative embodiments recognize and take into account that changing a simulation during a training session may be desirable. For example, the illustrative embodiments recognize and take into account that the simulation for a particular operator may be changed based on the performance of the operator.

In one illustrative example, an apparatus comprises an aircraft, a display system associated with the aircraft, a sensor system associated with the aircraft, and a training processor configured to be connected to the aircraft. The training processor is configured to receive information about an operator, generate constructive data for a number of simulation objects, generate simulation sensor data using the constructive data, and present the simulation sensor data with live sensor data generated by a sensor system on the display system. The training processor is further configured to identify a performance of the operator based on a policy and modify a simulation based on the performance of the operator.

Turning now to FIG. 9, an illustration of a training system is depicted in the form of a block diagram in accordance with an illustrative embodiment. In this illustrative example, training system **900** includes aircraft **902**. Aircraft **902** is an example of an aircraft that may be used in training environment **100** in FIG. **1**. Aircraft **902** may be used in place of or in addition to aircraft **104** in FIG. **1**.

Aircraft **902** may be used to train crew **904**. Crew **904** may include one or more human operators that operate aircraft **902**. For instance, crew **904** may include a pilot and a copilot on a mission using aircraft **902**. In another example, crew **904** includes only a single human operator. In still other illustrative examples, crew **904** may include operators in aircraft **902**, while other members of crew **904** are performing operations on the ground before returning to aircraft **902**.

As depicted, aircraft **902** includes computer system **906**. Computer system **906** may comprise a number of computers. When more than one computer is present in computer system **906**, these computers are in communication with each other using aircraft network **908**. Computer system **906** includes the control system for aircraft **902**. For example, computer system **906** includes at least one of flight controls, a health monitoring system, a communications system, or other suitable types of control systems for aircraft **902**.

In this illustrative example, computer system **906** also includes display system **910**. Display system **910** comprises one or more display devices in aircraft **902**. For example, display system **910** may include one or more display devices in the flight deck of aircraft **902**. Display system **910** may display simulated objects **912** and live objects **914** to crew **904** during simulation **916**. Simulation **916** may include a number of missions or tasks for crew **904**. In some illustrative examples, display system **910** may be used as an input device for crew **904** to input commands or communicate with entities outside aircraft **902**.

As illustrated, aircraft **902** also has network interface **918** configured for communication over wireless communications link **920** with remote computer system **922**. In this illustrative example, remote computer system **922** may be located in a ground station.

In one illustrative example, remote computer system **922** sends data **924** over wireless communications link **920** to network interface **918** in aircraft **902**. Network interface **918** receives data **924** and distributes data **924** between computers in computer system **906** in aircraft network **908**. In a similar fashion, computer system **906** sends data from network interface **918** over wireless communications link **920** to remote computer system **922**. In this manner, aircraft **902** and a ground station, a vehicle, or some other suitable platform that houses remote computer system **922** may communicate with each other.

In this illustrative example, data **924** may be selected from at least one of constructive data, virtual data, live data, instructions, operator information, mission information, or some other suitable type of data. Data **924** is used for simulation **916** in this illustrative example.

As depicted, remote computer system **922** includes learning management system **926** and learning record system **928**. When data **924** is received over wireless communications link **920**, data **924** may be processed by learning management system **926**. For example, when data **924** from aircraft **902** indicates that crew **904** has a passing score for a mission, learning management system **926** determines the next mission for crew **904**. In another illustrative example, learning management system **926** uses data **924** to rank crew **904** against other entities in the mission, or performs some other suitable operation on data **924**, depending on the particular implementation.

Learning record system **928** is a storage device in this illustrative example. Learning record system **928** stores data **924** received from aircraft **902**. Additionally, learning record system **928** stores other information about one of crew **904**, simulation **916**, and other suitable types of information.

In some examples, data **924** includes report **930**. Report **930** includes an analysis of tasks performed by crew **904** during simulation **916**. Report **930** is stored in learning record system **928** to be used during debriefing of crew **904** after simulation **916** is completed. For example, a human instructor may review the results of simulation **916** in report **930** during an after-action debriefing session with crew **904**. In other illustrative examples, learning management system **926** generates report **930** from data **924** sent to remote computer system **922** over wireless communications link **920**. In still other illustrative examples, components within aircraft **902** send report **930** to learning management system **926**.

In this illustrative example, training processor **932** is configured to be connected to aircraft **902**. In particular, training processor **932** is configured to be removably connected to aircraft **902** such that training processor **932** can be removed from aircraft **902** if desired.

In this depicted example, training processor **932** is configured to be held in pod **934**. Pod **934** may be internally or externally connected to aircraft **902**. In one illustrative example, pod **934** with training processor **932** is located inside of aircraft **902**. In another illustrative example, pod **934** with training processor **932** is located outside of aircraft **902**. In the illustrative example, training processor **932** may be integrated as part of pod **934** or may be a separate component placed inside a housing of pod **934**.

As depicted, pod **934** is an external pod configured to be connected to the exterior of aircraft **902**. Training processor **932** in pod **934** communicates with computer system **906** through interface **936**. Interface **936** may take various forms. For example, interface **936** may be weapons bus **726** in FIG. **7**, or may be another suitable type of bus systems.

As illustrated, training processor **932** takes the form of hardware and includes software. Training processor **932** includes training software **938** and number of simulation programs **940**. Training software **938** may be the same or different software as training software **120** running on computer system **118** in aircraft **104** in FIG. **1**.

Number of simulation programs **940** may be implemented using the same simulation programs as number of simulation programs **130** in computer system **140** in FIG. **1**. In other examples, number of simulation programs **940** are different than number of simulation programs **130**. Number of simulation programs **940** are used to run simulation **916** in this illustrative example.

As depicted, training processor **932** is configured to receive information **942** about crew **904**. In particular, training processor **932** is configured to receive information **942** about operator **944** in crew **904**. In the illustrative example, operator **944** may be, for example, without limitation, a pilot, a copilot, a navigator, a weapons operator, or some other suitable operator.

Information **942** may be part of data **924** sent over wireless communications link **920** by remote computer system **922**. For instance, learning management system **926** sends information **942** to training processor **932** for use in performing simulation **916**.

In other examples, information **942** may be input by operator **944** using one or more controls in aircraft **902**. In still other illustrative examples, training processor **932** may receive information **942** in some other suitable manner, depending on the particular implementation. Information **942** is used during simulation **916** to modify simulation **916** for operator **944**. Types of information **942** are described in more detail with reference to FIG. **11**.

As depicted, training processor **932** generates constructive data **946**. Constructive data **946** is for simulated objects **912** in simulation **916**. Constructive data **946** may be simulated in addition to or in place of constructive data **134** generated by computer system **140** in FIG. **1**.

In this illustrative example, training processor **932** also receives virtual data **136** from number of training devices **132** in FIG. **1**. Virtual data **136** is part of data **924** sent over wireless communications link **920** in this illustrative example. Training processor **932** processes virtual data **136** to form virtual data **948** in a format that may be displayed on display system **910** to operator **944** in the flight deck of aircraft **902**.

Further, training processor **932** also receives live sensor data **950** from sensor system **952** associated with aircraft **902**. Live sensor data **950** is an example of live sensor data **121** in FIG. **1**.

In these illustrative examples, computer system **906** also may generate ownship data **951**. Ownship data **951** is data describing aircraft **902**. Ownship data **951** may include, for example, at least one of a position of aircraft **902**, a speed of aircraft **902**, and other suitable data.

From constructive data **946**, training processor **932** generates simulation sensor data **954**. Simulation sensor data **954** is an example of simulation sensor data **123** in FIG. **1**. Simulation sensor data **954** and live sensor data **950** generated by sensor system **952** are presented to crew **904** on display system **910**.

In this depicted example, simulation **916** includes number of operations **956** to be performed by crew **904**. Each mission in simulation **916** includes number of operations **956** for that particular mission. In other words, an operation in number of operations **956** is an objective within a mission in simulation **916**. For instance, when simulation **916** is landing aircraft **902**, crew **904** performs various tasks to land aircraft **902** in a desired manner.

In another example, when simulation **916** is for neutralizing a threat, aircraft **902**, along with one or more of live objects **914** and simulated objects **912** work together to neutralize the simulated threat. In still other examples, simulation **916** includes multiple objectives such that number of operations **956** needs to be performed for each objective in the mission.

In this depicted example, number of operations **956** includes various types of actions. For instance, number of operations **956** includes performing a set of tasks during a phase of flight such as taxiing, takeoff, ascent, cruising, decent, landing, or some other phase of flight. As an example, an operation in number of operations may be to land the aircraft. In other illustrative examples, number of operations **956** includes operations selected from one of releasing a payload, flying in a formation, operating in stealth mode, completing a rescue, or other suitable types of operations.

As number of operations **956** is performed by crew **904**, training processor **932** evaluates crew **904**. In particular, training processor **932** identifies performance **958** of operator **944** for one or more of number of operations **956**. Performance **958** is determined based on at least one of constructive data **946**, virtual data **948**, and live sensor data **950**. Training processor **932** then modifies simulation **916** based on performance **958** of operator **944**.

As depicted in FIG. **9**, simulation **916** may be modified to tailor simulation **916** to operator **944** based on performance **958** and to have a difficulty that is closer to performance **958** for operator **944**. The difficulty of simulation **916** may be selected to increase the learning, skill, or both learning and skill for operator **944** as compared to running the same version of simulation **916**, regardless of the skill level of operator **944**. In this manner, more efficient training of operator **944** may occur using training system **900**.

The illustration of training system **900** and training processor **932** in aircraft **902** in FIG. **9** is not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. For instance, aircraft **902** may receive data **924** from other aircraft in simulation **916** over wireless communications link **920**. As an example, aircraft **902** receives position, speed, and mission status information from other aircraft participating in simulation **916**. In a similar fashion, aircraft **902** may send data **924** to these aircraft. As a result, live aircraft in training environment **100** can work together to complete a mission in simulation **916**.

Moreover, training processor **932** is configured to operate in a tethered mode or an untethered mode in this illustrative example. For instance, training processor **932** operates in tethered mode **740** or untethered mode **742**, as described with reference to FIG. **7**.

In some illustrative examples, training processor **932** generates substantially all of simulation **916** onboard aircraft **902**. In this illustrative example, training processor **932** is in untethered mode **742** such that none of data **924** is received from remote computer system **922**. Accordingly, simulation **916** is modified using information **942** about operator **944**, performance **958** of operator **944** during number of operations **956**, live sensor data **950** from sensor system **952**, and any additional instructions loaded onto pod **934** before aircraft **902** left the ground.

In still other illustrative examples, wireless communications link **920** may be established between aircraft **902** and live objects **914** operating in training environment **100**. For instance, one of live objects **914** may be another aircraft operating in simulation **916** with aircraft **902**. Aircraft **902** and the other aircraft communicate over wireless communications link **960**. In particular, network interface **962** in aircraft **902** receives these communications sent from live objects **914** over wireless communications link **960**. In this example, aircraft **902** is still in untethered mode **742**, but receives data from other aircraft such that training processor **932** may use this data in modifying simulation **916**.

In other illustrative examples, an additional wireless communications link (not shown) is established directly from remote computer system **922** to network interface **962** in pod **934** of aircraft **902**. In this example, remote computer system **922** sends data **924** directly to pod **934**. Network interface **962** receives data **924** and distributes data **924** accordingly.

Referring next to FIG. **10**, an illustration of a training processor is depicted in the form of a block diagram in accordance with an illustrative embodiment. In this depicted example, training processor **932** from FIG. **9** is shown in more detail. FIG. **10** illustrates one manner in which training processor **932** may be implemented.

As depicted, training processor **932** includes virtual instructor **1000**. Virtual instructor **1000** is a system configured to evaluate performance **958** of operator **944** and other members of crew **904** during number of operations **956** in FIG. **9** in simulation **916**.

Virtual instructor **1000** is further configured to instruct operator **944** during simulation **916** based on performance

958 of operator 944. In particular, virtual instructor 1000 provides feedback 1002 to operator 944 in this illustrative example.

As illustrated, virtual instructor 1000 runs on training processor 932 within pod 934 in aircraft 902 in FIG. 2. In this manner, evaluations and instructions provided by virtual instructor 1000 are performed in real time, without sending data 924 to remote computer system 922 in FIG. 9 for processing. Moreover, virtual instructor 1000 may be used in addition to or in place of a human instructor to evaluate and instruct operator 944.

Virtual instructor 1000 may include hardware and software in these illustrative examples. In this depicted example, virtual instructor 1000 includes assessment module 1004 and instructor module 1006.

Assessment module 1004 is configured to evaluate operator 944 during number of operations 956 to identify performance 958. Assessment module 1004 identifies performance 958 based on policy 1008.

In this depicted example, policy 1008 comprises set of rules 1010. Set of rules 1010 are rules for at least one of live sensor data 950, constructive data 946, ownship data 951, number of operations 956 of operator 944, or some other suitable type of rules. In other words, set of rules 1010 may include rules for one of the aforementioned categories or a combination thereof.

In one illustrative example, set of rules 1010 may include a rule to ensure operator 944 maintains an altitude 2000 feet below a target. In another illustrative example, set of rules 1010 may include a rule that once a determination is made that operator 944 has performed at a particular level for one of number of operations 956, the difficulty of simulation 916 increases to a maximum.

As operator 944 performs number of operations 956 in simulation 916, assessment module 1004 in virtual instructor 1000 evaluates operator 944 in real time. Assessment module 1004 then identifies performance 958 by comparing policy 1008 to events 1012 performed by operator 944 during number of operations 956 in simulation 916. In particular, assessment module 1004 compares set of rules 1010 for number of operations 956 to events 1012 performed by operator 944.

In this illustrative example, events 1012 take various forms. Events 1012 are events performed by operator 944 during number of operations 956. For example, events 1012 may be selected from one of toggling a switch, moving a control, altering the position of a control surface, pressing a button, using a communications system, or some other task needed to perform one or more of number of operations 956 in simulation 916.

For instance, when performing a mission, one of number of operations 956 may include climbing to a desired altitude. In another example, one of number of operations 956 may include remaining steady at a desired altitude while releasing a payload. Set of rules 1010 includes the desired altitude for these examples. As operator 944 performs number of operations 956, assessment module 1004 determines whether operator 944 has reached or maintained the desired altitude. Accordingly, performance 958 is determined by assessment module 1004 using set of rules 1010.

In some cases, training processor 932 is configured to generate report 930 of performance 958 of operator 944. In this illustrative example, assessment module 1004 in virtual instructor 1000 generates report 930. Training processor 932 then sends report 930 over wireless communications link 920 in FIG. 9 to at least one of learning management system 926, learning record system 928, or some other suitable location.

Report 930 may be a report of performance 958 for one or more of number of operations 956 in simulation 916 or a report of performance 958 for substantially all operations performed by operator 944 during simulation 916. In still other examples, report 930 is sent in response to a request from remote computer system 922.

As illustrated, assessment module 1004 sends events 1012 to instructor module 1006. Instructor module 1006 uses events 1012 to generate feedback 1002 for operator 944 based on performance of operator 944 in real time. Instructor module 1006 also may have a set of rules in these examples. In some cases, one of events 1012 may be an omission by operator 944. For instance, if operator 944 fails to move aircraft 902 to the desired altitude, events 1012 will reflect that omission.

As depicted, instructor module 1006 generates feedback 1002 for operator 944 as operator 944 performs number of operations 956. Based on events 1012, instructor module 1006 generates feedback 1002 in real time to assist operator 944 in training using aircraft 902 in simulation 916.

In this illustrative example, feedback 1002 takes a variety of different forms. For instance, feedback 1002 may be selected from at least one of communications 1014, evaluation 1016, instructions 1018, or other suitable types of feedback for operator 944. In particular, generating feedback 1002 comprises generating at least one of a visual indication, text, an audible alert, or verbal instructions for operator 944.

For example, instructions 1018 may be communicated to operator 944 as text displayed on display system 910 in FIG. 9. In another illustrative example, evaluation 1016 may be a score flashing as a visual indication on display system 910. In still other illustrative examples, audible instructions 1018 or evaluation 1016 are communicated to operator 944 using a communications system.

As illustrated, communications 1014 may take the form of audio communications 1020 and video communications 1022. Both audio communications 1020 and video communications 1022 are sent by instructor module 1006 to computer system 906. In this illustrative example, audio communications 1020 is sent to computer system 906 to be given to operator 944 over a communications system or speaker system in the flight deck of aircraft 902.

Audio communications 1020 may take the form of a simulated audio communication from one of simulated objects 912 in FIG. 9 in response to events 1012 by operator 944. For instance, the simulated object may be air traffic control and audio communications 1020 may be a communication from air traffic control. In other illustrative examples, audio communications may indicate an enemy threat to aircraft 902 that operator 944 has failed to target.

In this illustrative example, video communications 1022 are configured to be displayed on display system 910 for operator 944. Video communications 1022 provide examples of missions and video communication with other entities such as simulated objects 912 or live objects 914, among other types of video communication.

As depicted, evaluation 1016 is an evaluation of operator 944 based on performance 958. Evaluation 1016 takes a number of different forms in this illustrative example. For instance, evaluation 1016 may indicate that operator 944 has passed or failed a mission or part of a mission in simulation 916. In other illustrative examples, evaluation 1016 is a warning for operator 944. In still other illustrative examples, evaluation 1016 may include a status of operator 944, such as a percentage of completion of a mission in simulation 916.

In this illustrative example, instructor module 1006 also provides instructions 1018 to operator 944. Instructions 1018 may be instructional cues for operator 944 to better perform number of operations **956** in simulation **916**. For example, instructor module **1006** may guide operator **944** through steps of a landing sequence. In another illustrative example, instructor module **1006** may correct operator **944** during number of operations **956**. As a result, operator **944** receives real time feedback **1002** from virtual instructor **1000** to optimize training in simulation **916** with aircraft **902**.

In this illustrative example, virtual instructor **1000** in training processor **932** is also configured to modify simulation **916** based on performance **958** of operator **944**. In particular, virtual instructor **1000** is configured to modify set of parameters **1026** for simulation **916** based on performance **958** of operator **944**.

As used herein, a "set" of items is zero or more items. For instance, set of parameters **1026** is zero or more parameters. In other words, a set may be a null set in some illustrative examples. Accordingly, virtual instructor **1000** may not modify any parameters of simulation **916** when set of parameters **1026** is a null set.

As depicted, virtual instructor **1000** in training processor **932** is configured to modify at least one of constructive data **946**, training software **938**, or other parameters for simulation **916**. When constructive data **946** is modified by virtual instructor **1000**, simulation sensor data **954**, generated by training software **938**, reflects the modification. In other words, new simulated sensor data for the modified constructive data **946** is generated for simulation **916**. Moreover, simulated objects **912** may be presented to operator **944** in a different manner than before constructive data **946** was modified.

When training software **938** is modified by virtual instructor **1000**, a change in the program code that is run or used for training software **938** may occur. Accordingly, simulation **916** may be generated differently in response to the change in program code. Moreover, processing of virtual data **948**, generation of simulated objects **912**, and generation of simulation sensor data **954** may occur in a different manner than before training software **938** was modified.

In this illustrative example, after receiving events **1012** from assessment module **1004**, instructor module **1006** in virtual instructor **1000** sends simulation commands **1024** to modify set of parameters **1026** for simulation **916**. In some illustrative examples, set of rules **1010** may include rules for parameters in set of parameters **1026**.

Simulation commands **1024** may be sent to number of simulation programs **940** in some illustrative examples. In this depicted example, simulation commands **1024** are sent substantially concurrently with feedback **1002**. In other illustrative examples, feedback **1002** and simulation commands **1024** may be sent at different times, depending on the particular implementation.

As illustrated, simulation commands **1024** are instructions to change set of parameters **1026** for simulation **916** in a desired manner based on performance **958** of operator **944**. Set of parameters **1026** is described in more detail with reference to FIG. **12**.

With the use of training processor **932** with virtual instructor **1000**, training system **900** in FIG. **9** operates more efficiently and effectively. For example, because all of the components needed to run and modify simulation **916** are housed in aircraft **902**, operator **944** may get a more realistic simulated mission experience than with some currently used systems.

Additionally, the architecture of training processor **932** allows aircraft **902** to operate in an untethered mode for a longer period of time while modifying simulation **916** based on performance **958** of operator **944**. Thus, operator **944** may receive better training than with some currently used systems because operator **944** receives feedback **1002** in real time, while virtual instructor **1000** modifies simulation **916** to reflect performance **958** of operator **944**. In this manner, individualized training for operator **944** is realized.

Although assessment module **1004** and instructor module **1006** are shown in training processor **932** in FIG. **10**, the illustration of virtual instructor **1000** and its components is not meant to limit the manner in which illustrative embodiments may be implemented. In other illustrative examples, assessment module **1004**, instructor module **1006**, or both may be located in another location other than in training processor **932**. For instance, assessment module **1004**, instructor module **1006**, or both may be located in a remote location to training processor **932**. As a result, simulation **916** may be modified using information from assessment module **1004** or instructor module **1006** received from the remote location.

In one illustrative example, assessment module **1004** is located in remote computer system **922**. In this case, remote computer system **922** is part of a ground station. Accordingly, data **924** is exchanged over wireless communications link **920** between aircraft **902** and remote computer system **922** to determine performance **958**.

In still other illustrative examples, components shown within training processor **932** may be located in other types of platforms other than aircraft **902** and a ground station. For example, components within training processor **932** may be located in a location selected from one of a mobile platform, a stationary platform, a ship, a tank, another aircraft, a ground vehicle, an air traffic control station, or some other suitable location. With this type of implementation, simulation commands **1024** used to change simulation **916** may be received by training processor **932** from the remote location.

Referring now to FIG. **11**, an illustration of information about an operator is depicted in the form of a block diagram in accordance with an illustrative embodiment. In this illustrative example, information **942** about operator **944** used by training processor **932** during simulation **916** in FIG. **9** is shown.

As depicted, information **942** includes skill level **1100**, scheduled mission **1102**, operator performance **1104**, mission scores **1106**, number of completed tasks **1108**, and mission status **1110** that is sent to training processor **932** over wireless communications link **920** in FIG. **9**. In some illustrative examples, other types of information in addition to or in place of the ones shown may be sent in information **942**.

In this illustrative example, skill level **1100** is a skill level for operator **944**. Skill level **1100** is a ranking compared to other operators in some examples. In other examples, skill level **1100** denotes mastery of a desired number of tasks.

Scheduled mission **1102** is a next mission for operator **944**. In this example, learning management system **926** in FIG. **9** sends scheduled mission **1102** to training processor **932** such that a desired sequence of missions is completed for operator **944**. For instance, learning management system **926** determines an order of skills to be learned by operator **944**.

In this depicted example, operator performance **1104** is performance **958** in FIG. **9** of operator **944** in previous missions. Operator performance **1104** is specific to operator **944** currently operating aircraft **902**. Performance **958** indicates whether the operator has passed a previous mission, failed a previous mission, or some other suitable measure of performance.

As illustrated, mission scores **1106** are scores on previous missions. From mission scores **1106**, training processor **932** determines whether to proceed to the next mission or to repeat a mission or one of number of operations **956** in FIG. **9** for a particular mission.

Number of completed tasks **1108** are completed tasks for operator **944**. Number of completed tasks **1108** includes a list of tasks that operator **944** has completed and also may include a list of tasks yet to be completed by operator **944**. Training processor **932** uses number of completed tasks **1108** in generating simulation **916**. For instance, simulation **916** may be generated based on number of completed tasks **1108** for operator **944** such that operator **944** does not need to repeat a task that has already been mastered.

In this illustrative example, mission status **1110** is a status for the mission in simulation **916**. For instance, simulation **916** may be modified or restarted to adapt to performance **958** of operator **944**. Mission status **1110** reflects the status of the mission as one of completed, incomplete, in progress, and some other suitable type of status.

As illustrated, training processor **932** uses information **942** to modify simulation **916**. In this manner, training processor **932** provides individualized training for operator **944** based on at least one of skill level **1100**, scheduled mission **1102**, operator performance **1104**, mission scores **1106**, number of completed tasks **1108**, or mission status **1110**. Information **942** also may be combined with performance **958** of operator **944** such that training processor **932** can modify simulation **916** in real time to reflect the appropriate difficulty level for operator **944** in simulation **916**.

Turning next to FIG. **12**, an illustration of a set of parameters for a simulation is depicted in the form of a block diagram in accordance with an illustrative embodiment. In this depicted example, an example of parameters that may be implemented in set of parameters **1026** in FIG. **10** for simulation **916** in FIG. **9** is shown.

As illustrated, set of parameters **1026** for simulation **916** comprises entity location **1200**, entity count **1202**, threat level **1204**, mission duration **1206**, and level of control **1208**. In some illustrative examples, set of parameters **1026** may include parameters in addition to or in place of the ones shown. One or more of set of parameters **1026** is modified based on performance **958** of operator **944** in FIG. **9**.

In this depicted example, entity location **1200** is the location of simulated objects **912** in FIG. **9**. In this illustrative example, entity location **1200** may be modified in response to performance **958**. For example, if operator **944** is performing poorly on a mission, entity location **1200** may be changed to give operator **944** more time to prepare for number of operations **956** in FIG. **9**.

In another illustrative example, when operator **944** is performing well, entity location may be adjusted accordingly. For instance, the speed of entities may be increased such that entity location **1200** is closer to aircraft **902** in FIG. **9**. In other words, simulation **916** is altered to give operator **944** less time to react.

In yet another illustrative example, entity location **1200** may be modified to reflect an entity in a stationary position. For instance, if targeting a moving entity with a weapons system is too difficult for operator **944** based on performance **958** of operator **944**, entity location **1200** is changed to reflect a stationary entity.

As illustrated, entity count **1202** is a number of entities present in simulation **916**. Entity count **1202** may be increased or decreased in response to performance **958** of operator **944**. For example, entity count **1202** is increased to make simulation **916** harder for operator **944** when the entities are enemy aircraft.

In another example, entity count **1202** is increased to provide additional friendly entities to assist operator **944** to perform number of operations **956**. In a similar fashion, entity count **1202** may be decreased to make simulation **916** more or less difficult, depending on performance **958** of operator **944**. These modifications occur in real time.

Threat level **1204** indicates a threat level for entities within simulation **916**. For instance, threat level **1204** may reflect a threat level for simulated objects **912**, live objects **914**, both seen in FIG. **9**, or a combination thereof. Threat level **1204** indicates whether an entity is a friend or an enemy of aircraft **902**. Moreover, threat level **1204** also indicates neutral entities.

In some illustrative examples, threat level **1204** indicates a threat level in the simulated environment around aircraft **902** in addition to a threat level of any entities within the environment. For instance, threat level **1204** may indicate that aircraft **902** has reached enemy airspace, dangerous weather is approaching, or some other suitable threat is present in simulation **916**. In this illustrative example, threat level **1204** is modified in response to performance **958** of operator **944** to change the difficulty of simulation **916**.

As illustrated, mission duration **1206** is a length of time specified for performing number of operations **956**. In other words, mission duration **1206** is the amount of time given to operator **944** to perform a mission. In this illustrative example, mission duration **1206** is modified to provide operator **944** more or less time to complete number of operations **956**.

In this depicted example, level of control **1208** is a level of control for aircraft **902**. In particular, level of control **1208** is modified based on performance **958** of operator **944** to give operator **944** more or less control of aircraft **902**. For instance, during a landing simulation, virtual instructor **1000** in FIG. **10** may operate one or more controls for aircraft **902**, while operator **944** operates different controls.

As performance **958** is successful for those controls, virtual instructor **1000** may give operator **944** a greater level of control **1208** of aircraft **902**. In other words, virtual instructor **1000** gives operator **944** control over a greater number of controls during landing until operator **944** has mastered the landing simulation.

In a similar fashion, virtual instructor **1000** can decrease level of control **1208** that operator **944** has over aircraft **902**. Decreasing level of control **1208** allows operator **944** to focus on particular aspects of simulation **916** to achieve a desired level of performance **958**.

In other illustrative examples, simulation **916** may be modified to repeat or restart a mission. For instance, if performance **958** of operator **944** indicates that operator **944** should repeat one or more of number of operations **956**, simulation **916** is modified to repeat the one or more operations that are identified in number of operations **956**. In this manner, operator **944** receives individualized training in real time using virtual instructor **1000** and simulation **916**. Further, with these and other types of modifications to simulation **916**, operator **944** may learn more quickly to perform number of operations **956** in which performance **958** has a desired level.

Although the illustrative examples for an illustrative embodiment are described with respect to aircraft **902**, an illustrative embodiment may be applied to other vehicles other than aircraft **902** such as, for example, without limitation, a submarine, a personnel carrier, tank, a train, an automobile, a bus, a spacecraft, a surface ship, and other suitable vehicles. More specifically, the vehicle may be a surface ship, a tank, a personnel carrier, a train, a spacecraft, a space station, a satellite, a submarine, and an automobile, among others. In other words, simulation **916** may include one or more of these objects.

Training processor **932** and its components also may be implemented in a stationary structure such as a power plant, a bridge, a dam, a house, a manufacturing facility, a building, and other suitable platforms. These stationary structures may be part of simulation **916**, house components used in training system **900**, or a combination thereof.

With reference now to FIG. **13**, an illustration of an aircraft is depicted in accordance with an illustrative embodiment. Aircraft **1300** is an example of a physical implementation of aircraft **702** in FIG. **7**.

In this illustrative example, aircraft **1300** has wing **1302** and wing **1304** attached to body **1306** of aircraft **1300**. Engine **1308** and engine **1310** are connected to body **1306**. Additionally, aircraft **1300** has tail section **1311**. In these depicted examples, aircraft **1300** has pods **1312**. In these depicted examples, an illustrative embodiment may be implemented using pod **1314**. Pod **1314** may include a training processor such as training processor **720** in FIG. **7**.

Turning now to FIG. **14**, an illustration of a training processor is depicted in accordance with an illustrative embodiment. In this illustrative example, training processor **1400** is an example of an implementation of training processor **720** in FIG. **7**.

In this illustrative example, training processor **1400** has a shape configured for placement into pod **1314** in FIG. **13**. In this example, housing **1401** of training processor **1400** has length **1402** and width **1404**. Length **1402** may be, for example, about 8.5 inches. Width **1404** may be about 4.5 inches in this illustrative example. Of course, housing **1401** of training processor **1400** may have any shape that can be placed into a pod such as pod **1314**.

Housing **1401** has connectors **1406**. These connectors are configured to be connected to a pod interface such as a weapons bus.

Turning now to FIG. **15**, an illustration of a training processor in a pod is depicted in accordance with an illustrative embodiment. In this illustrative example, training processor **1400** is shown in pod **1314**. A cover for pod **1314** has been removed to allow for placement of training processor **1400** into pod **1314**. As can be seen, training processor **1400** has a shape configured for placement into interior **1500** of pod **1314**. Further, pod **1314** also may include other components used for training exercises in addition to training processor **1400**.

Examples of other components that may be present in pod **1314** include, for example, a network interface, a computer, a power supply, a global positioning system receiver, a recording system to record missions for post mission analysis, and other suitable devices.

The illustration of aircraft **1300** and training processor **1400** are not meant to imply physical or architectural limitations to the manner in which an illustrative may be implemented. Other types of aircraft and other shapes for training processors may be used in other illustrative embodiments. For example, although training processor **1400** is shown as a component in a housing that is placed into pod **1314**, training processor **1400** may be implemented differently in other illustrative embodiments. For example, training processor **1400** may be built into pod **1314** rather than as a removable component for pod **1314**. In this example, pod **1314** may, in essence, be training processor **1400**.

With reference now to FIG. **16**, an illustration of a flowchart of a process for performing a training session is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **16** may be used to perform training session **106** in training environment **100** in FIG. **1**.

The process begins by preparing a mission for the training session (operation **1600**). In this operation, a mission may be defined to have a number of different scenarios for the training session. These scenarios may include, for example, without limitation, an air-to-air engagement scenario, an air-to-ground strike scenario, a joint-operation scenario including other aircraft, and other suitable scenarios. With one or more of the different illustrative embodiments, multiple scenarios may be performed in a training session that may require more time, airspace, and equipment availability than possible to perform in a single training session or flight.

In this operation, the definition of a training area, the aircraft armament, sensor parameters, behavior, routes, and other information may be set. The process then prepares each of the scenarios identified for the mission (operation **1602**). This operation includes defining the various parameters and equipment to be used in each scenario in the mission as planned in operation **1600**. The operation may include identifying both live objects, as well as simulation objects.

The process performs the mission (operation **1604**). In performing the mission, the data for the different scenarios is loaded onto the computer system for the training environment. Operation **1604** may be implemented using training software, such as training software **400** in FIG. **4**. The number of live aircraft in the mission may then take off to perform the mission with simulation data being sent to the number of live aircraft. Further, during the flying of the mission, different scenarios may be repeated and rerun until desired results are obtained or until fuel becomes low.

Thereafter, mission debriefing is performed (operation **1606**). In this operation, information from the mission is presented for review and analysis. For example, the database from the aircraft in the mission, as well as simulation data generated by the computer system, may be viewed. For example, flight paths and events that occurred during the mission may be viewed. Thereafter, a performance assessment is performed (operation **1608**), with the process terminating thereafter. An assessment of the performance of the crew in the aircraft may be performed based on the results from the mission.

With reference now to FIG. **17**, an illustration of a flowchart of a process for training in an aircraft is depicted in accordance with an illustrative embodiment. The process in FIG. **17** may be implemented in a training environment, such as training environment **300** in FIG. **3**. In particular, this process may be implemented in a computer system, such as computer system **118** in aircraft **104** in FIG. **1**.

The process begins by receiving simulation data during a training session (operation **1700**). In this illustrative example, the simulation data is received by the training software running on the aircraft. The communications system uses a wireless communications link to receive the simulation data. The process then generates simulation sensor data from the simulation data (operation **1702**). In these illustrative examples, this process is performed in the aircraft. In other illustrative embodiments, a portion of the training software may operate in another location with the simulation sensor data being transmitted to the aircraft.

The process receives live sensor data from a sensor system in the aircraft (operation **1704**). The process then presents the simulation sensor data with the live sensor data on a display system in the aircraft (operation **1706**), with the process terminating thereafter.

With reference now to FIG. **18**, an illustration of a flowchart of a process for generating simulation sensor data received in an aircraft is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **18** may be implemented in software, such as training software **400** in FIG. **4**. The simulation sensor data generated by the operations in this flowchart may be an example of simulation sensor data **447**, which may be used to generate simulation object data **448** in FIG. **4**.

The process begins by receiving simulation sensor data (operation **1800**). The process identifies a number of objects in the simulation sensor data (operation **1802**). The process then selects an unprocessed object from the number of objects identified for processing (operation **1804**).

Thereafter, the process generates simulation sensor data about the selected object identified in the simulation data (operation **1806**). This information may include, for example, without limitation, an identification of the object, a graphical indicator to use for the object, and other suitable information. These objects may be, for example, without limitation, aircraft, vehicles, missile sites, ships, missiles in flight, and other suitable objects.

Operation **1802** may be performed using a model for the sensor system. The model of the sensor system may include models of different sensors in the sensor system. Operation **1806** generates simulation sensor data in the same fashion that an actual sensor system would generate sensor data in an aircraft.

The sensor data is the same format as sensor data generated by physical sensor systems in the aircraft. A determination is then made as to whether the simulation data includes information about another unprocessed object (operation **1808**). If the simulation data includes information about another unprocessed object, the unprocessed object is selected, and the process returns to operation **1802**. Otherwise, the process terminates. The simulation sensor data may then be processed by the computer system in the aircraft in the same manner as with live sensor data generated by sensors for the aircraft.

With reference now to FIG. **19**, an illustration of a flowchart of a process for generating information about objects detected by sensors is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **19** may be implemented in software, such as training software **400** in FIG. **4**. This process may be used to generate information about both live objects and simulation objects in these illustrative examples. The same process may be used, because the simulation sensor data is in the same format and contains the same type of information as the live sensor data generated by physical sensors in the aircraft. The operations illustrated in FIG. **19** may be used to generate data, such as live object data **446** and simulation object data **448** in FIG. **4**.

The process begins by receiving sensor data from a sensor (operation **1900**). In operation **1900**, the sensor data may be either live sensor data or simulation sensor data in these examples. The process then identifies objects in the sensor data (operation **1902**). An object identified in the sensor data is selected for processing (operation **1904**). Information about the object is generated based on the sensor data (operation **1906**). This information may include, for example, an identification of the object, a graphical indicator to use for the object, and other suitable information. Thereafter, the information is placed into a database of objects (operation **1908**). Next, a determination is made as to whether additional unprocessed objects are present in the sensor data (operation **1910**). If additional objects are present, the process returns to operation **1904**. Otherwise, the process terminates.

With respect to simulation sensor data that may be received, the information about the object also may include an indication that the object is a simulation object rather than a live object. In some illustrative embodiments, parallel processes may run to process live sensor data and simulation sensor data. One process may process all live sensor data, while the other process processes only simulation sensor data. As a result, all of the objects identified by the process processing simulation sensor data are associated with objects that are simulation objects rather than live objects. The information for each type of object may be stored in separate locations such that an identification of a live object versus a simulation object may be made.

With reference now to FIG. **20**, an illustration of a flowchart of a process for presenting object information is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **20** may be used to process live object data and simulation object data generated by the process in FIG. **17**.

The process begins by identifying objects that have been detected by an aircraft (operation **2000**). These objects include ones detected by the sensors in the aircraft and those sent in simulation information to the aircraft. The identification may be made using an object database, such as object database **450** in FIG. **4**.

Thereafter, the process selects an unprocessed object from the detected objects for processing (operation **2002**). The process retrieves information about the object from the object database (operation **2004**). This information may include, for example, without limitation, an identification of the object, a location of the object, and other suitable information. The process then presents the object on the display system (operation **2006**). For example, a particular type of graphical indicator may be used, depending on the identification of the object type. For example, one type of graphical indicator may be used for friendly aircraft, while another type of graphical indicator may be used for enemy aircraft.

The display of graphical indicators may be presented on display system **438** using number of video display devices **439** in FIG. **4**. Additionally, in some cases, the operator or operators in the aircraft may receive audio cues through devices, such as number of audio devices **440** in display system **438**. In the different illustrative embodiments, these audio cues also may be generated based on the reception of simulation data **410**.

Next, the process determines whether additional unprocessed objects are present (operation **2008**). If additional unprocessed objects are present, the process returns to operation **2002**. Otherwise, the process terminates.

In selecting an object for processing in the process in FIG. **20**, all objects in the object database are identified and processed. The objects include those for objects actually detected by the aircraft and those sent in the simulation information. In this manner, the presentation of objects, both live and simulated, are presented on the display in the same manner in which live objects are normally presented on the display. Of course, the presentation of the display may include a different indicator for simulation objects as compared to live objects, depending on the particular implementation.

With reference now to FIG. **21**, an illustration of a flowchart of a process for sending data during a training session is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **21** may be implemented in a computer system, such as computer system **118** in aircraft **104** in FIG. **1**.

The process begins by obtaining ownship information about the aircraft (operation **2100**). This information may be obtained from a system, such as a global positioning system unit and/or an inertial navigation unit. This ownship information may include, for example, a longitude, a latitude, an elevation, an attitude, an altitude, a velocity, and other suitable information.

The ownship information also may include information about whether a control for launching a weapon has been activated. The process then sends the collected information to a remote location from the aircraft for processing (operation **2102**), with the process terminating thereafter.

With reference now to FIG. **22**, an illustration of a flowchart of a process for training in an aircraft is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **22** may be implemented using training system **700** in FIG. **7**. This process may be used to train crew **703** in aircraft **702**.

The process begins by the training processor generating constructive data (operation **2200**). The training processor then generates simulation sensor data using the constructive data (operation **2202**).

The training processor then presents the simulation sensor data with the live sensor data generated by a sensor system for the aircraft on a display system in the aircraft (operation **2204**) with the process terminating thereafter. In operation **2204**, the training processor may send simulation sensor data without the live sensor data. The aircraft computer system may combine the simulation sensor data with the live sensor data for presentation.

With reference now to FIG. **23**, an illustration of a flowchart of a process for training in an aircraft with a training processor in accordance with an illustrative embodiment. The process illustrated in FIG. **23** may be implemented in training processor **720** located in pod **724** for training the crew of an aircraft.

The process begins by a training processor receiving simulation data from a ground station over a wireless communications link to a pod in which the training processor is located (operation **2300**). This data may be received using network interface **733** and pod **724** in the illustrative examples. The simulation data may include at least one of constructive data and virtual data.

The training processor then generates simulation sensor data using the constructive data (operation **2302**). The training processor then presents the simulation sensor data with the live sensor data generated by a sensor system for the aircraft on a display system in the aircraft (operation **2304**), with the process terminating thereafter. The crew may train using the data presented on the display system of the aircraft.

Turning next to FIG. **24**, an illustration of a flowchart of a process for training in an aircraft is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **24** may be implemented using training system **900** in FIG. **9**. In particular, the process illustrated in FIG. **24** may be implemented in training processor **932** shown in FIG. **9** and FIG. **10**. This process may be used to train crew **904** in aircraft **902** in FIG. **9**.

The process begins by receiving information about an operator from a wireless communications link (operation **2400**). In this illustrative example, information **942** about operator **944** is received over wireless communications link **920** by network interface **918** in aircraft **902**. Information **942** is sent from remote computer system **922** in this illustrative example.

Next, the training processor generates constructive data (operation **2402**). For example, training processor **932** generates constructive data **946**. The training processor then generates simulation sensor data using the constructive data (operation **2404**). In this depicted example, training processor **932** generates simulation sensor data **954** from constructive data **946**.

The training processor then presents the simulation sensor data with live sensor data generated by a sensor system for the aircraft on a display system in the aircraft (operation **2406**). For instance, training processor **932** presents simulation sensor data **954** with live sensor data **950** generated by sensor system **952** to operator **944** using display system **910** in aircraft **902**.

Thereafter, the training processor identifies a performance of the operator based on a policy (operation **2408**). In this illustrative example, training processor **932** identifies performance **958** of operator **944** based on policy **1008**.

The training processor then generates feedback for the operator based on the performance of the operator in real time (operation **2410**). In this illustrative example, training processor **932** generates feedback **1002** for operator **944** based on performance **958** of operator **944** in real time such that operator **944** can adjust maneuvers to better complete number of operations **956** in simulation **916**.

Next, the training processor modifies a simulation based on the performance of the operator (operation **2412**) with the process terminating thereafter. In operation **2412**, training processor **932** modifies simulation **916** based on performance **958** of operator **944**. Training processor **932** may modify at least one of constructive data **946**, training software **938**, or both, based on performance **958** of operator **944**. In this manner, training processor **932** adapts simulation **916** to the skill level of operator **944**.

Turning next to FIG. **25**, an illustration of a flowchart of a process for modifying a simulation is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **25** may be implemented using training system **900** in FIG. **9**. In particular, the process illustrated in FIG. **25** may be implemented during operation **2412** in FIG. **24** by training processor **932** shown in FIG. **9** and FIG. **10**. This process may be used to train crew **904** in aircraft **902** in FIG. **9**.

The process begins by generating simulation commands based on a performance of the operator (operation **2500**). In this illustrative example, instructor module **1006** generates simulation commands **1024** to modify set of parameters **1026** for simulation **916**.

Next, the process sends the simulation commands to a number of simulation systems (operation **2502**). For example, instructor module **1006** sends simulation commands **1024** to number of simulation programs **940**.

Thereafter, the number of simulation systems modifies a set of parameters for the simulation based on the simulation commands (operation **2504**). In operation **2504**, simulation commands **1024** may be used to modify set of parameters **1026** for simulation **916** including one of entity location **1200**, entity count **1202**, threat level **1204**, mission duration **1206**, level of control **1208**, and other suitable parameters. Set of parameters **1026** may result in alterations to constructive data **946**, program code in training software **938**, or a combination thereof.

The process then presents a modified simulation to the operator based on the performance of the operator (operation **2506**), with the process terminating thereafter. In operation **2506**, training processor **932** presents a modified simulation to operator **944** based on performance **958** of operator **944** on display system **910**. In this manner, training processor **932** provides individualized training to operator **944** based on performance **958**.

The flowcharts and block diagrams in the different depicted embodiments illustrate the architecture, functionality, and operation of some possible implementations of apparatus and methods in different illustrative embodiments. In this regard, each block in the flowcharts or block diagrams may represent a module, segment, function, and/or a portion of an operation or step.

In some alternative implementations, the function or functions noted in the block may occur out of the order noted in the figures. For example, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. Also, other blocks may be added in addition to the illustrated blocks in a flowchart or block diagram.

Thus, the different illustrative embodiments provide a method and apparatus for training with aircraft. In one illustrative embodiment, an apparatus comprises an aircraft. The apparatus also comprises a communications system, a display system, a sensor system, and a computer system, all of which are associated with the aircraft. The communications system is configured to exchange data with a number of remote locations using a wireless communications link. The computer system is configured to run a number of processes to receive simulation data received through the communications system over the wireless communications link, receive live data from the sensor system associated with the aircraft, and present the simulation data and the live data on the display system.

With one or more of the different illustrative embodiments, training using live aircraft may be reduced in expense and time. For example, with one or more of the different illustrative embodiments, multiple scenarios may be performed during a training session. For example, a first scenario may involve locating a ground target, and a second scenario may involve an air-to-air combat mission. These two scenarios may be performed during one training session more easily than with all live objects. For example, the scheduling and availability of aircraft and ground systems is less of a problem, because simulation objects may be used for one or more of the objects. Additionally, the amount of fuel and maintenance needed may be reduced because of the use of simulation objects in place of live objects.

The different illustrative embodiments can take the form of an entirely hardware embodiment, an entirely software embodiment, or an embodiment containing both hardware and software elements. Some embodiments are implemented in software, which includes, but is not limited to, forms, such as, for example, firmware, resident software, and microcode.

Furthermore, the different embodiments can take the form of a computer program product accessible from a computer-usable or computer-readable medium providing program code for use by or in connection with a computer or any device or system that executes instructions. For the purposes of this disclosure, a computer-usable or computer-readable medium can generally be any tangible apparatus that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

The computer-usable or computer-readable medium can be, for example, without limitation, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, or a propagation medium. Non-limiting examples of a computer-readable medium include a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk, and an optical disk. Optical disks may include compact disk-read only memory (CD-ROM), compact disk-read/write (CD-R/W), and DVD.

Further, a computer-usable or computer-readable medium may contain or store a computer-readable or usable program code such that when the computer-readable or usable program code is executed on a computer, the execution of this computer-readable or usable program code causes the computer to transmit another computer-readable or usable program code over a communications link. This communications link may use a medium that is, for example, without limitation, physical or wireless.

A data processing system suitable for storing and/or executing computer-readable or computer-usable program code will include one or more processors coupled directly or indirectly to memory elements through a communications fabric, such as a system bus. The memory elements may include local memory employed during actual execution of the program code, bulk storage, and cache memories, which provide temporary storage of at least some computer-readable or computer-usable program code to reduce the number of times code may be retrieved from bulk storage during execution of the code.

Input/output or I/O devices can be coupled to the system either directly or through intervening I/O controllers. These devices may include, for example, without limitation, keyboards, touch screen displays, and pointing devices. Different communications adapters may also be coupled to the system to enable the data processing system to become coupled to other data processing systems or remote printers or storage devices through intervening private or public networks. Non-limiting examples are modems and network adapters and are just a few of the currently available types of communications adapters.

The description of the different illustrative embodiments has been presented for purposes of illustration and description, and it is not intended to be exhaustive or limited to the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. Further, different illustrative embodiments may provide different features as compared to other illustrative embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the embodiments, the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

The invention claimed is:

1. An apparatus comprising:
an aircraft;
a display system associated with the aircraft;
a sensor system associated with the aircraft; and
a training processor configured to:
be connected to the aircraft;
receive information about an operator of the aircraft;
generate constructive data for simulated objects;
generate simulation sensor data using the constructive data, such that constructive data comprises data generated by a software program to simulate an object;
present the simulation sensor data, with live sensor data generated by the sensor system, to a computer system that controls the display system, the training processor being distinct from the computer system that controls the display system;
identify a performance of the operator based on a policy, the performance comprising responses to presentations of: constructive data, live sensor data, and virtual data, such that virtual data comprises data generated through a training device that receives a manual input; and

modify, using an instructor module receiving events from an assessment module, a simulation based on the performance of the operator, such that a program code for the training processor changes when performing a mission, such that, in operation the training processor:

connects to the aircraft;

receives the information about the operator of the aircraft;

generates constructive data for the simulated objects;

generates the simulation sensor data using the constructive data;

presents the simulation sensor data, with the live sensor data generated by the sensor system, to the computer system that controls the display system, the training processor being distinct from the computer system that controls the display system;

identifies the performance of the operator based on the policy, the performance comprising responses to the presentations of: the constructive data, the live sensor data, and the virtual data;

and modifies, using the instructor module receiving the events from the assessment module, the simulation based on the performance of the operator.

2. The apparatus of claim **1**, wherein the policy comprises a set of rules for at least one of the live sensor data, the constructive data, ownship data, or a number of operations performed by the operator.

3. The apparatus of claim **1**, wherein the training processor is configured to generate a report of the performance of the operator and send the report over a wireless communications link to at least one of a learning management system or a learning record system.

4. The apparatus of claim **1**, further comprising the training processor being configured to generate feedback directly to the operator, based on the performance of the operator, in real time, such that, in operation, the training processor generates feedback directly to the operator, based on the performance of the operator, in real time.

5. The apparatus of claim **4**, wherein the feedback is selected from at least one of communications, an evaluation of the operator, or instructions for the operator.

6. The apparatus of claim **4**, wherein generating the feedback comprises generating at least one of a visual indication, text, an audible alert, or verbal instructions for the operator.

7. The apparatus of claim **1**, wherein the information about the operator is selected from at least one of a skill level, a scheduled mission, an operator performance, mission scores, a number of completed tasks, or a mission status.

8. The apparatus of claim **1**, wherein modifying the simulation based on the performance of the operator comprises modifying a set of parameters for the simulation based on the performance of the operator.

9. The apparatus of claim **8**, wherein the set of parameters comprises at least one of an entity location, an entity count, a threat level, a mission duration, or a level of control of the aircraft.

10. The apparatus of claim **1**, wherein in being configured to modify the simulation based on the performance of the operator, the training processor is configured to modify at least one of the constructive data or a training software for the simulation, such that, in operation, the training processor modifies the at least one of the constructive data or the training software for the simulation.

11. The apparatus of claim **1** further comprising:

a network interface associated with the aircraft, wherein the network interface is configured to exchange data using a wireless communications link, wherein the training processor receives virtual data using the wireless communications link, wherein the training processor receives the live sensor data from the sensor system associated with the aircraft, and wherein the training processor generates the simulation sensor data using at least one of the constructive data, the virtual data, and the live sensor data, such that, in operation, the network interface exchanges data using the wireless communications link, wherein the training processor receives virtual data using the wireless communications link, wherein the training processor receives the live sensor data from the sensor system associated with the aircraft, and wherein the training processor generates the simulation sensor data using at least one of the constructive data, the virtual data, and the live sensor data.

12. The apparatus of claim **1**, wherein the training processor is configured to operate in an untethered mode in which the constructive data is generated internally, such that, in operation, the training processor operates in the untethered mode.

13. The apparatus of claim **1**, wherein the training processor is configured for use in a pod for the aircraft, such that, in operation, the training processor is used in the pod on the aircraft.

14. A training system comprising:

a training processor configured to:

be connected to an aircraft;

receive information about an operator;

generate constructive data for simulated objects;

generate simulation sensor data using the constructive data, such that constructive data comprises data generated by a software program to simulate an object;

present the simulation sensor data, with live sensor data generated by a sensor system for the aircraft, to a computer system that controls a display system in the aircraft, the training processor being distinct from the computer system that controls the display system;

identify a performance of the operator based on a policy, the performance comprising responses to presentations of: constructive data, live sensor data, and virtual data, such that virtual data comprises data generated through a training device that receives a manual input; and

modify, using an instructor module receiving events from an assessment module, a simulation based on the performance of the operator, such that a program code for the training processor changes when performing a mission, such that, in operation, the training processor:

connects to the aircraft;

receives information about the operator;

generates constructive data for the simulated objects;

generates the simulation sensor data using the constructive data;

presents the simulation sensor data, with the live sensor data generated by the sensor system for the aircraft, to the computer system that controls the display system in the aircraft, the training processor being distinct from the computer system that controls the display system;

identifies the performance of the operator based on the policy, the performance comprising the responses to the presentations of: the constructive data, the live sensor data, and the virtual data; and

modifies, using the instructor module receiving the events from the assessment module, the simulation based on the performance of the operator, such that the program code for the training processor changes when performing the mission.

15. The training system of claim **14** further comprising:

a pod configured to be connected to the aircraft, wherein the training processor is configured to be held in the pod, such that, in operation, the pod connects to the aircraft and holds the training processor.

16. The training system of claim **14**, wherein the training processor is configured to generate feedback directly to the operator based on the performance of the operator in real time, such that, in operation, the training processor generates the feedback directly to the operator based on the performance of the operator in real time.

17. The training system of claim **14**, wherein in modifying the simulation based on the performance of the operator, the training processor is configured to modify a set of parameters for the simulation based on the performance of the operator, such that, in operation, the training processor modifies the set of parameters for the simulation based on the performance of the operator.

18. A method for training in an aircraft, the method comprising:

receiving, from a wireless communications link, information about an operator of the aircraft;

generating, by a training processor, constructive data, such that constructive data comprises data generated by a software program to simulate an object;

generating, by the training processor, simulation sensor data using the constructive data;

presenting, by the training processor, the simulation sensor data with live sensor data generated by a sensor system for the aircraft, to a computer system that controls a display system in the aircraft, the training processor being distinct from the computer system that controls the display system;

identifying, by the training processor, a performance of the operator based on a policy, the performance comprising responses to presentations of: constructive data, live sensor data, and virtual data, such that virtual data comprises data generated through a training device that receives a manual input; and

modifying, by the training processor using an instructor module receiving events from an assessment module, a simulation based on the performance of the operator, such that a program code for the training processor changes when performing a mission.

19. The method of claim **18** further comprising:

generating, by the training processor, feedback directly to the operator based on the performance of the operator in real time.

20. The method of claim **18**, wherein modifying the simulation based on the performance of the operator further comprises:

modifying, by the training processor, at least one of the constructive data or a training software for the simulation.

* * * * *